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SPECIFICITY OF LIGHT ACTION IN TUBERCULOSIS

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INTRODUCTORY NOTE

In the following paper a study is carried out of the clinical and experimental results of the use of the light wave band lying between 330 and 380 millimicrons. The specificity of light action has been proven for rickets, and, it is believed, there is a similar specificity in tuberculosis. This band, commonly known as the long wave ultraviolet, has hitherto been supposed inactive. The clinical part of the study was carried out, taking advantage of the fact that few waves shorter than 320 millimicrons reach the earth in sea-level cities. In the experimental part, light screens were used as described. Further experiments are in progress.

I. PRESENT STATUS OF THE TREATMENT OF TUBERCULOSIS

Tuberculosis of the bones and joints is but one manifestation of a generalized disease. Orthopaedic treatment is carried out to combat the local condition, but only in conjunction with attempts to eradicate the disease from the body as a whole. Specific procedures obtain, as in any other manifestation of the disease. The aim of general treatment is utilization to the highest degree of the body's reparative powers, by means of rest in bed, a high caloric diet, and fresh air. This treatment is augmented by drugs, tuberculin, heliotherapy, etc., as indicated. The study of the relationship of light to tuberculosis is at the present time the most promising field of research in connection with the disease.

II. EVIDENCES OF SPECIFICITY OF PHYSICAL AND PHYSIOLOGICAL ACTION IN THE ELECTROMAGNETIC SPECTRUM

The electromagnetic spectrum in its broadest sense has been in the past few years intensively studied both as regards its physical nature and its physiological action. It consists of a series of frequencies at a constant speed measured in hypothetical wave lengths in terms of units of the metric system. These wave lengths cover apparently the entire range of distances from a millionth of a millimeter to hundreds of miles from crest to crest. That a different wave length has a different effect on contact with matter is easily seen. The most recently discovered and the shortest are the cosmic rays, .001 to .01 Angström units in length, supposedly generated by the synthesis of matter, specifically the generation of helium from hydrogen. These rays have as yet no known physiological action. They have been only superficially studied and their discovery is very recent. The gamma rays of radium, produced by the disintegration of radium, have a very well known and definite physical action on matter,—splitting off an electron, for example. These rays also have a physiological effect on protoplasm, which is a destructive one, and this effect is utilized in the treatment of malignancy. X-rays have well known effects, both physical and physiological. The visible rays differ from the rest purely by virtue of their visibility. The optic nerve responds to these rays and responds differentially because of the construction of the rods and cones of the retina, but, as the color blue differs only from the color red, physically, on the basis of a difference in wave length, it can therefore be stated that the physiological action of blue is different from that of the red. The physiological action of the infra-red rays is the sensation of heat which they produce. The longest group of rays with which we are familiar has, as far as is known, no physiological action whatever. They are the Hertzian rays and are used at the present time primarily as carrier waves in radio.

The term "light", however, in its more restricted sense and in the sense in which we usually use it, is that portion of the electromagnetic spectrum which reaches us from the sun. This includes the invisible ultraviolet and the invisible infra-red, as well as the visible part of the spectrum. It does not, of course, include all of the ultraviolet or all of the infra-red. Darkness, on the other hand, is not a direct opposite of light, as darkness means only absence of the visible light, and darkness may contain any amount of ultraviolet or infra-red light.

If light is to be considered as a physiological agent, it may be seen from the above that it is of the nature of a drug. It may thus be compared to opium, from which many derivatives of varying natures may be refined. Thus, the ultraviolet end of the spectrum may have an entirely different effect upon the living organism from the infra-red end. In fact, these effects may be so different that one may neutralize the other and the total effect be of no value whatever. It is important, therefore, to study the effect of light, especially with regard to the type of light being used,—

that is to say, the particular part of the spectrum involved. The ultraviolet, even, cannot be considered as a whole and the organism treated with ultraviolet light. It has already been proven by Hess that there are definite variations in the ultraviolet spectrum. It has been shown that it is the rays around 300 millimicrons in length which are effective in the treatment of rickets and that rays longer than this, but still in the ultraviolet spectrum, may have no effect whatever on the rachitic process. Some bands in the ultraviolet are likewise found to be bactericidal while other bands are not. Also, the variation in penetration is great throughout the ultraviolet spectrum. It has been found that certain parts of the ultraviolet spectrum are stimulating to the muscles and apparently increase muscle tone. On the other hand, certain portions of the infra-red help to bring about muscular relaxation.

In brief, if a definite effect can be found in a definite part of the spectrum, then it is best to utilize only that part of the spectrum to produce this effect, as the opposing effect, or at least different effects physiologically, may be found in other parts of the spectrum.

The sources of light utilized must be considered. The commonest source is, of course, the sun. At sea level the percentage of ultraviolet visible and infra-red differs greatly from that percentage found at high altitudes. In artificial sources of light, the carbon arc cannot even be considered as a definite source, as there is a tremendous variation in the type of carbon used and the amount of electrical current used to heat the carbon. The quartz mercury vapor lamp produces, it is true, a large amount of ultraviolet light, but this varies markedly with the age of the burner and its spectrum is a line spectrum, producing large quantities of certain groups of waves and very small quantities between these groups. The sun and the carbon arc, on the other hand, are essentially continuous spectra which have a smooth emission throughout their range. There is a definite specificity of effect extending through the whole spectrum and, with various types of light, various effects are obtainable. It can be reasoned therefore that, when certain effects are produced, which are known to be the result of a definite band of wave lengths, that band is present in the light producing the effect.

III. COMPARISON OF SUNLIGHT AT VARIOUS ELEVATIONS

In observing the results of the treatment of tuberculosis in various parts of the world where light has been used as an adjunct to treatment, improvement of the condition has been definite enough to assume that there has been a curative effect of some sort as a result of the light.

In the Swiss Alps, in the clinics of Rollier, Bernard, and others, excellent results have been obtained with sun therapy. These results, to be sure, are not only the results of light therapy but very excellent antituberculous therapy in general, with sunlight as the chief adjunct. In Perrysburg, N. Y., at a considerably lower level, excellent and comparable

results have been obtained under very similar general conditions. Here the ultraviolet intensity is considerably less than that in the Swiss Alps; also the infra-red intensity is less. The sun's spectrum is entirely different in these two particular regions and yet comparable results have been obtained.

In addition to this are the reports from the many seaside sanitaria in which the results are equal to those found in any other locality. Here the absorption of the short ultraviolet rays is so great, because of the density of the atmosphere, that there are very few rays of less than 313 millimicrons in length. In the cities, where smoke is added to the density of the atmosphere, especially at sea level, there is still greater absorption of the short ultraviolet rays. Reyn, in his investigation, comes to the conclusion that, in the treatment of tuberculosis by sunlight, being as satisfactory in the mountains as at the seashore, it is not the short ultraviolet rays found only in the mountains which are essential.

It is felt by some investigators, that the effective treatment of tuberculosis is by means of whole light rather than any one particular portion of the spectrum. It is true that in many experiments a very definite improvement in the general nutrition, metabolism, etc., has been noted on exposure of well animals to whole light as compared to those living in the dark, but the question of a specific action in a specific type of condition may very possibly be a different matter from the general improvement of body condition and welfare.

The work of Hess can again be referred to as an example of this specificity. It has seemed from the above that if specificity of action is of importance in tuberculosis, the short band which is effective in rickets, namely 300 to 313 millimicrons, is decidedly not the band which is active in tuberculosis, because of the results obtained equally well in localities where the sun is rich in the short waves as in those localities where there is an extremely small amount of these particular rays. It must, therefore, be deduced that the effective radiation in tuberculosis is present in the sun at all of these elevations. As the ultraviolet at sea level is practically non-existent below 313 millimicrons and non-existent even somewhat higher in sea-level cities, where smoke and dust are additional factors in absorption, the effective wave lengths would seem to be above 320 millimicrons in all probability. Of course, visible and infra-red rays are also present at all of the sanitaria, but it has long been felt that radiation through window glass is ineffectual. While window glass will pass wave lengths as short as 340 millimicrons, the intensity is so low up to 380 millimicrons that in order to give sufficient dosage, exposure times would have to be lengthened to the point of impracticability. All of which strongly suggests the theory that effective radiation lies somewhere in the range between 320 and 380 millimicrons.

IV. TOTAL RADIATION DOSAGE OF SUN THERAPY

Before attempting to test this theory the question of dosage must be considered. The use of the sun has been outlined by various authors and

much attention has been given to the time of exposure. Time of exposure, however, is most untrustworthy as a basis for dosage. The variations in the intensity in the Swiss Alps are not great, but at sea level and in cities, one hour's treatment might bear no relation whatever to the same time in Switzerland. This would be true both as regards intensity and spectral distribution. However, spectroscopic studies can be made of various localities and the intensity will then be a definite measure of the total radiation at that locality. Rollier has outlined a scheme which works the best for his patients, but this scheme may not necessarily be the best at other altitudes and under other and different climatic conditions. Bernhard, who like Rollier is in the Alps, has made very complete studies with regard to the effects of solar radiation on the different slopes of the mountains and his dosages are similar to Rollier's. However, the increased total radiation at the higher altitude and the relatively increased radiation in the near ultraviolet and visible with the relative decrease in the infra-red (Coblentz) makes exposure at sea level and in cities a different matter from the point of view of dosage, as well as wave length.

If the sun is to be used as a therapeutic measure, it is important to determine what dosage has been given and what dosage should be given. The daily fluctuation of intensity of total radiation is very great. An exposure for an hour on one day may represent only one-half the total radiation on another.

A means of recording the actual radiation given was devised as follows: The apparatus consisted of a Moll thermopile mounted under a fluorite plate to allow transmission of all radiations up to 12,000 millimicrons. The following of the sun in its transit throughout the day is accomplished by means of a clock-driven equatorial mounting with a hand-operated altitude and azimuth adjustment which maintains the surface of the thermopile at right angles to the incident rays. This thermopile is connected to a Richard millivoltmeter. The excursions of the writing point are measured in millimeters directly. The thermopile-galvanometer or radiometer was then calibrated by Dr. J. S. Hetzel and Prof. Henry Laurens so that the excursions of the writing point could be read directly in terms of gram calories per square centimeter per minute.

The Moll thermopile was set up on the roof of the building in which the treatments were given and wired to the recording galvanometer which was inside the building. The resistance of the connecting wires was determined and found to be small enough to give no appreciable change in the deflection. Records were made over a series of all the sunny days throughout the year and the total radiation determined from the millimeter gram calorie curve. Typical values were as follows:

May 22, 1927	1.0 gm. cal./cm².min.	moderately clear
June 12, 1927	1.2 " " " "	clear
June 13, 1927	1.4 " " " "	clear
June 18, 1927	0.1 " " " "	cloudy
June 22, 1927	0.8 " " " "	clear, hazy
July 8, 1927	1.6 " " " "	clear
November 22, 1927	1.4 " " " "	clear

Variations are seen to be extreme. It is thus possible to record accurately the total radiation dosage of the sun. The unit of radiation is very conveniently taken as one gram calorie per square centimeter per minute. It has been found that usually the radiation for a given treatment time will remain approximately the same. That is, even on a day on which the sun goes under frequent clouds, the radiation between times will remain constant. Of course, there are many days on which there are rapid changes in the amount of radiation, but these are not so common.

Following a routine somewhat similar to that of Rollier, after zoning, patients were exposed for ninety minutes dorsal and ninety minutes ventral when the radiation was one gram calorie per square centimeter per minute. When the radiation was one and five-tenths gram calories per square centimeter per minute, the patient would be receiving one-half again as much radiation per square centimeter of body area per minute of time, and therefore the dose was cut to sixty minutes. On the other hand, on days when the radiation was below one, the time was lengthened in order to give the same dosage.

At present, the length of time of treatment, that is, the dose to be given, is empiric. Bernhard states that some patients can be as long as eight hours in the sun daily and that others are very susceptible. This is undoubtedly true, but it is undetermined whether there is any advantage in sun treatment over and above a certain length of time. It seems likely that the development of pigmentation is a protective reaction and that the effect of treatment is nulled by too long exposure because of the development of pigment, which decreases the absorption, even little as that absorption normally is. However, it has been found here at sea level that an exposure of ninety gram calories per square centimeter on any given body area produces a slight tan which reaches a constant color in about one month after starting treatment and remains throughout the year, if the dosage is carefully followed.

Thus, it can be seen that the gram calorie per square centimeter is a very useful unit of dosage for sun treatment and that by means of the simple radiometer, this dosage can be controlled accurately. Of course, the more accurate the radiometer and its calibration, the more accurate will be the dosage given, but a variation of five or even ten minutes either way will cause only a small change in the amount of tan. It is the variations shown by the radiometer, and not the actual values which are of most importance from a dosage point of view.

As the sun is often so elusive and the various sorts of artificial heliotherapy are so plentiful, it would be a great help to reduce the dosage of the artificial sources to the same units as those used for sun treatment. This is by no means an easy thing to do. For the measurements made were with total radiation or with the amount of total radiation limited only by the transmission of the fluorite lens (12,000 millimicrons). All artificial sources of light have an entirely different spectral distribution qualitatively as well as quantitatively, and a total radiation of one gram calorie

per square centimeter per minute from a quartz mercury vapor lamp, for example, would give such a tremendous preponderance of ultraviolet that it would be equal to many times the ultraviolet dose in one unit of sun radiation. The infra-red element in carbon arcs is also so great, by virtue of their proximity, compared with the sun, that here again the dose could not be compared.

All light sources are similar to the old-fashioned shot-gun prescriptions, many of which may contain identical drugs, but in different quantities. A teaspoonful of one would be entirely different from a teaspoonful of another.

The intensity of a given light source, such as a carbon arc, can be measured, and the intensity of the various parts of its spectrum measured. When this has been done, the dosage can be measured in time units, providing the distance and amperage are kept constant.

V. EFFECTS OF SUN THERAPY IN CITIES AT SEA LEVEL

As a result of these observations, it was felt that possibly tuberculosis could be as well cured in the cities at sea level by means of sunlight, as in any other place. A group of patients were therefore given heliotherapy at the New Haven Hospital, which is at sea level and in the midst of the City of New Haven, where the smoke present in the atmosphere is approximately that of the average sea-level manufacturing community. The general dietary régime and general care of the tuberculosis of the patient was carefully supervised in order to be certain that it was adequate. The light treatment was given as closely following the Rollier method as possible, but dosage controlled by means of the radiometer described. Approximately ninety gram calories per square centimeter were given dorsally and ventrally daily. Careful records were kept of the entire time of exposure of the patient. In many of these cases, the sunlight was augmented in winter by carbon-arc therapy, using a type of arc which will be subsequently described. These cases included, in so far as possible, all forms of surgical tuberculosis in which the pulmonary activity was either very slight or entirely quiescent. All these forms were included for comparison with results in other clinics. Treatment for specific lesions was carried out as indicated. A summary of these cases is given in the accompanying tables.

It can be readily seen that the most striking effect of the treatment of these patients was the healing of the sinuses. Many of them were broken down areas, discharging large amounts daily. No local heliotherapy was given in any case. The sinuses were dressed as frequently as necessary, but only with dry dressings and were kept covered throughout the treatments. In no case was any open area exposed to the sun or arc light.

Special attention is called to Case 29. On admission, this patient showed a draining ankle and draining sinuses from a postoperative wound following a bilateral epididymectomy. The biopsy from both the ankle

Name and History Number	*Age*	*Diagnosis*	*Duration before Admission*	*Sinus*	*Diagnosis made on basis of*	*Total Helio. in days*	*Sun*	*Artificial*	*Additional Treatment*	*Immediate Result*	*End Result Time after Discharge*
#1 C. H. 33140	14 yrs.	Tbc. cervical adenitis.	4 years	Yes	Pathological specimen. Biopsy. Microscopic.	128	0	128	Dry dressings	Healed	Well 2½ years
#2 B. F. M. 7200	10 yrs.	Tbc. cervical adenitis.	6 months	Yes	Microscopic and tuberculin.	110	80	30	Aspiration	Healed	Well 2 yrs., 3 months
#3 D. F. 22795	30 yrs.	Retroperitoneal lymphadenitis.	1 year	No	X-ray and exploration.	416	259	157	Exploratory laparotomy.	Well	Well 1½ years
#4 V. T. 26063	18 yrs.	Tbc. peritonitis.	1 week. Pulmonary of long standing.	No	Physical examination. Pulmonary. Appendicitis 1 yr. before	351	283	68	Thoracoplasty for lung.	Local asymptomatic.	Died, embolus following rib resection 1 year later.
#5 I. S. 27115	5 yrs.	Tbc. mesenteric glands.	1 year	No	Tuberculin and x-ray. Calc. abdominal glands.	280	191	89	None	Well	Well 1½ years
#6 E. L. 27789	3 yrs.	9, 10, 11 Dorsal tbc. Pulmonary tbc.	2 years	No	X-ray and tuberculin positive.	1126	786	340	Plaster shell. Brace.	No increased destruction by x-ray.	Transferred to sanatorium 6 months. Pulmonary.
#7 A. K. 32130	10 mos.	Pulmonary tbc. Pleurisy with effusion. Thoracotomy Tbc. otitis media. Tbc. ulna. Long bone tbc.	1 month	Yes—ulna and thoracotomy	Microscopic. Pathological specimen. X-ray. Tuberculin positive. Biopsy.	906	678	228	Thoracotomy. A & T inc. and drainage middle ear	Ulna healed. Pulmonary improved. Weight normal. Thoracotomy healed.	Ulna healed 2 years. Pulmonary progressed, probably reinfected.
#8 C. P. 32644	2 yrs.	Tbc. of right hip with abscess.	6 months	Yes	Tuberculin positive. Microscopic.	779	597	182	Traction 2 years. Cast.	Ankylosed hip. Sinus healed.	Same. 1½ years

					positive. Microscopic.				2 years. Cast.	Ankylosed hip. Sinus healed.	Same. 1½ years

Name and History Number	*Age*	*Diagnosis*	*Duration before Admission*	*Sinus*	*Diagnosis made on basis of*	*Total Helio. in days*	*Sun*	*Artificial*	*Additional Treatment*	*Immediate Result*	*End Result Time after Discharge*
#9 P. C. 33501	3 yrs.	Tbc. empyaema. Thoracotomy. Phlyctenular conjunctivitis. Tbc. glands of neck.	1 year	Yes	Tuberculin positive. Microscopic. Biopsy. Pathological specimen.	465	396	69	Dry dressings	Well	Well 2½ years
#10 J. F. 35686	30 yrs.	Tbc. empyaema. Pulmonary tbc. Thoracotomy.	1 month	Yes	Sputum positive. X-ray. Microscopic. Biopsy.	444	356	88	Dry dressings	Well	Well 2½ years
#11 M. B. 36064	3 yrs.	Tbc. knee left.	4 months	No	Tuberculin test positive. X-ray shows only bone atrophy. X-ray of chest lymphatic tbc.	288	255	33	Traction in line of deformity. No immobilization after spasm was gone.	Well	Well 1½ years
#12 K. K. 36404	6 mos.	Tbc. otitis media. Tbc. mastoiditis. Tbc. tonsillitis. Tbc. cervical adenitis.	3 months	Yes	Tuberculin test positive. Microscopic from middle ear. Acid-fast bacilli.	200	161	39	Mastoidectomy.	Well. Healed	Well 3 years. Healed
#13 H. B. 36443	26 yrs.	Tbc. peritonitis.	6 months	Yes—after operation	X-ray lymphatic pulmonary tbc. Exploratory laparotomy. Tbc. peritonitis. Pathlgical specimen. Biopsy.	74	74	0	None	Healed	Well 3½ years
#14 D. L. 36828	14 yrs.	Tbc. hip.	12 years	Yes—following arthrodesis of hip at another hospital.	X-ray and operation. Biopsy.	47	0	47	Cast applied	Healed	Well 1 year

Name and History Number	*Age*	*Diagnosis*	*Duration before Admission*	*Sinus*	*Diagnosis made on basis of*	*Total Helio. in days*	*Sun*	*Artificial*	*Additional Treatment*	*Immediate Result*	*End Result Time after Discharge*
#15 A. R. 37132	5 yrs.	Tbc. peritonitis.	2 weeks		Exploratory laparotomy. Pathological specimen. Biopsy.	300	300	0	None	Well	Well 3½ years
#16 L. P. 37491	11 yrs.	Tbc. sacro-iliac.	1 week	No	X-ray. Tuberculin positive.	144	111	33	Traction. Plaster shell. Sacro-iliac support. No weight-bearing for 1 year.	Well. X-rays show no destruction.	Well 3 years. X-rays show repair.
#17 L. A. 40143	5 yrs.	Tbc. spine 11th dorsal. Paraplegia, beginning.	2 years	No	X-ray. Tuberculin positive.	250	128	122	Shells. Brace	Discharged in brace. No paraplegia.	Well 1 year
#18 J. B. 41248	30 yrs.	Tbc. empyaema.	1 year	Yes	Microscopic	35	35	0	None	Healed	No follow-up
#19 W. W. 41573	46 yrs.	Tbc. peritonitis. Tbc. cervical adenitis. Tbc. pulmonary. Tbc. laryngitis.	30 years	Yes—neck	X-ray. Exploratory laparotomy. Biopsy. Pathological specimen. Microscopic.	102	82	20	None	Neck and peritonitis well. Pulmonary improved. Laryngitis unimproved.	Same, 2 years
#20 J. R. 41906	10 yrs.	Tbc. cervical spine. Tbc. cervical adenitis.	5 weeks	No	X-ray of spine	164	164	0	Thomas collar 6 mos. and Bradford frame. Head traction 3 mos.	Free motion all directions.	Well 3 years
#21 R. P. 42639	20 yrs.	Tbc. of abdominal wall.	2 months	Yes	Pathological specimen. Microscopic.	199	181	18	Exploratory laparotomy.	Healed, secondary intention.	Slight recurrence of drainage 2 years
#22 E. S. 42955	3 yrs.	Tbc. cervical adenitis.	1 year	Yes	Tuberculin positive. X-ray lymphatic tbc. Microscopic.	163	149	14	Dry dressing	Healed	Well 3½ years
#23 G. P. 43154	1 yr.	Tbc. 10th dorsal vertebra. Pulmonary tbc, bilateral.	2 months	No	X-ray. Tuberculin positive.	865	645	220	Plaster shells. Brace.	Fusion by x-ray.	Well 1½ year

43278		Pulmonary tbc. bilateral.			positive.					by X-ray.	1½ year

Name and History Number	*Age*	*Diagnosis*	*Duration before Admission*	*Sinus*	*Diagnosis made on basis of*	*Total Helio. in days*	*Sun*	*Artificial*	*Additional Treatment*	*Immediate Result*	*End Result Time after Discharge*
#24 R. E. 43278	16 yrs.	Tbc kidney, right. Tbc. cystitis.	6 months	Yes—following right nephrectomy 6 mos. before admission.	Pathological specimen. Culture. Microscopic.	205	180	25	Nephrectomy. Bladder irrigation.	Healed. Slight frequency.	Well. No symptoms or physical signs. 3 years.
#25 V. B. 44810	4 yrs.	Tbc. cervical adenitis.	3 months	Yes	Tuberculin. Microscopic.	118	96	22	Dry dressings	Healed	Well 1½ years
#26 E. J. 44855	2 yrs.	Tbc. peritonitis.	1 month	No	Operation for intestinal obstruction. Biopsy.	85	27	58	None	Well	Well 2½ years
#27 L. R. 51226	25 yrs.	Pulmonary tbc. Tbc. knee.	3 years. Synovectomy 1 year before	No	X-ray. Advanced pulmonary.	529	339	190	Cast	Much improved. Moveable painless knee. 20° motion.	Pulmonary improved. 1 year. Motion the same. No flare-up.
#28 J. K. 53108	9 yrs.	Tbc. spine. Psoas abscess right leg.	4 years	Yes—Psoas abscess	X-ray of spine and lymphatic tbc. chest.	122	107	15	Dry dressings	Improved	Not improved
#29 V. F. 53121	27 yrs.	Tbc. of left ankle.	3 months	Yes	Microscopic and guinea pig.	470	330	140	Dry dressings to ankle. No immobilization.	Healed	Well 1½ years
#30 M. O. 58988	9 yrs.	Tbc. cervical adenitis.	3 months	Yes	Tuberculin positive. Chest x-ray lymphatic tbc.	113	54	59	Dry dressings	Healed	No follow-up
#31 H. F. 59981	5 yrs.	Tbc. cervical adenitis.	2 months	Yes	Microscopic	75	50	25	Dry dressings	Healed	Well 1½ years
#32 M. W. 60514	32 yrs.	Tbc. spine with psoas abscess. Pulmonary tbc.	3 years	Yes	Abscess biopsy. Smear.	50	34	16	Traction	Unimproved.	Died
#33 C. S. 60901	3 yrs.	Tbc. cervical adenitis. Lymphatic tbc.	2 months	Yes	Tuberculin positive. Smear. X-ray chest.	330	0	330	A. & T.	Healed	Well 9 months
#34 A. V. 67714	11 yrs.	Tbc. cervical adenitis.	2 months	No	Lymphatic tbc. chest. X-ray.	72	0	72	None	Well	Well 9 months

and the scrotum showed tuberculosis. The orthopaedic treatment of the ankle consisted merely of a posterior plaster splint for support, which the patient would not wear for any length of time. Healing of the sinuses was complete within four months after treatment. The patient would not keep the foot at rest but continually walked on it. X-rays showed haziness of the joint surfaces at first, but this disappeared and on discharge, after 470 days, the x-rays were entirely negative. The patient has been working steadily at hard manual labor for a year and a half since discharge. He entered the hospital prepared for one year's stay, but remained three months longer, purely as a precautionary measure. At this time he insisted upon discharge. The patient represents one of the isolated cases mentioned, with complete cure with full function. There is no limitation of any motion whatsoever in the ankle.

The group of cases is presented to demonstrate that cure of tuberculosis can be obtained with absence of the short ultraviolet rays below approximately 315 to 320 millimicrons, as these rays were absent in the solar radiation and negligible in the arc light used as a supplement.

VI. ARTIFICIAL LIGHT SOURCES

In considering artificial sources of light to substitute for the sun, a type of light as nearly approaching sunlight as possible in the locality where the sun treatment is given should be used. The spectrum of the sun, on perfect days, in the absence of dust and smoke, at sea level, begins slightly below 313 millimicrons. It increases in intensity up to about 460 millimicrons and is constant from that point to 500 millimicrons and then begins a slow decrease in the red and infra-red portions of the spectrum. The nearest approach to natural sunlight which has at present been developed, is the National Carbon Company's "Sunshine Carbon". The maximum intensity of this carbon lies at about 385 millimicrons and falls off from this point to about 500 millimicrons, where it remains constant through the red and infra-red. The ultraviolet emitted by this carbon shows a very small degree of short-wave ultraviolet, shorter than is found in the sun, but the amount of this is negligible. The ultraviolet production begins at about 300 millimicrons and at this point is comparatively small.

Even with this carbon, a drop in the amperage used from thirty to fifteen causes a drop in intensity to about one-fifth of that at thirty amperes. If the amperage is lowered to ten, the drop is about to one-twenty-fifth of the intensity. This drop necessitates such long exposures in order to receive the same quantity of light, that lamps of fifteen or ten amperes are impractical. Of course, the intensity over thirty amperes increases greatly, but the difficulties attendant upon installation of lamps using much higher amperage than thirty is so great that it again becomes impractical.

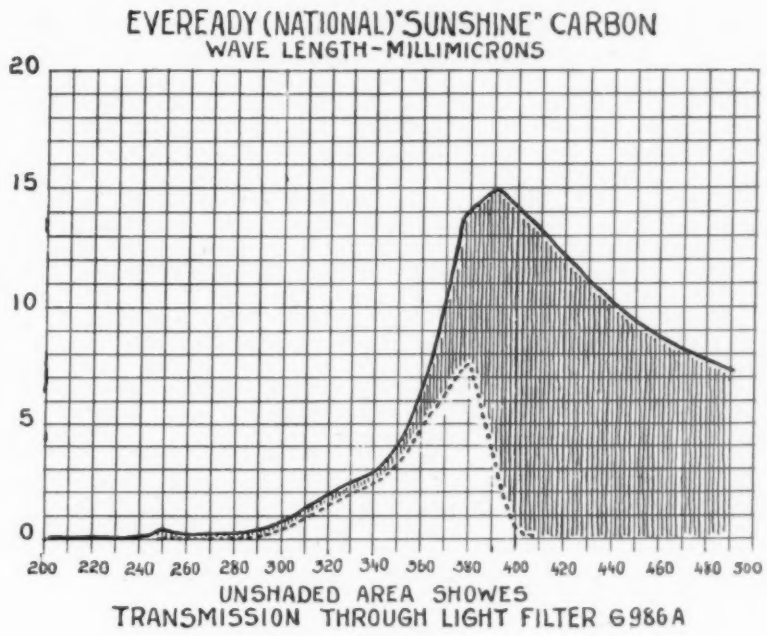

FIG. 1

By means of experiments, in the laboratory of Dr. H. Laurens, it was found that at a distance of one meter, the intensity of the total radiation of this light at thirty amperes was approximately one gram calorie per square centimeter per minute, using an aluminum reflector. These measurements were made by means of the thermopile galvanometer which has been described. Carbons were used in lamps manufactured by the Atlas Electric Devices Company, the "Pan-Ray-Arc", and were calibrated in this lamp. It has been found that in order to produce the proper quality and quantitative distribution of the spectrum, these carbons should be of the thirteen-millimeter diameter and use a current of approximately thirty amperes. This light source, therefore, is qualitatively approximately that of the sun as it is used here at sea level, except for the amount of infra-red. Quantitatively, of course, the intensity of this light varies inversely as the square of the distance from the patient.

The absorption of the short ultraviolet is not great, because the amount of air through which the light passes is, compared to the atmosphere through which the sunlight passes, very slight. There is, however, considerable absorption of the longer infra-red waves which are not present in sunlight, thus making the light still more closely similar to sunlight in the infra-red end of the spectrum. It is, of course, actually far from a close duplicate but contains a large amount of radiation in the bands between 320 and 380 millimicrons which is the particular band under study. It was with this source of light that the patients listed above were treated during bad weather and extreme cold.

VII. EXPERIMENTAL DATA

In order to check the clinical results described, it was determined to narrow the band of light artificially, excluding the visible rays and short ultraviolet by means of a light screen. The energy radiation curve of the carbon used is herewith reproduced. The filter selected to narrow the light band was Corning Glass Works "G986A". The energy transmission curve of this filter is seen in Figure 1. By combining these curves, the light energy passing through the filter is as shown in Figure 2. This curve allows the passage of a limited band of ultraviolet light between 320 and 400 millimicrons, with a very steep drop beyond 390 millimicrons. Maximum radiation is therefore between 320 and 380 millimicrons. The animals to be radiated were six young healthy guinea pigs. The tuberculosis strain was the H37 Saranac strain which produces a moderately severe infection which is progressive. Six guinea pigs were injected, using a tuberculin syringe, containing a suspension of living tubercle bacilli in saline, which was pierced through the thin abdominal wall directly into the peritoneal cavity. The suspension of bacilli was made and the following experiments carried out with the assistance of Dr. B. S. Brodie.

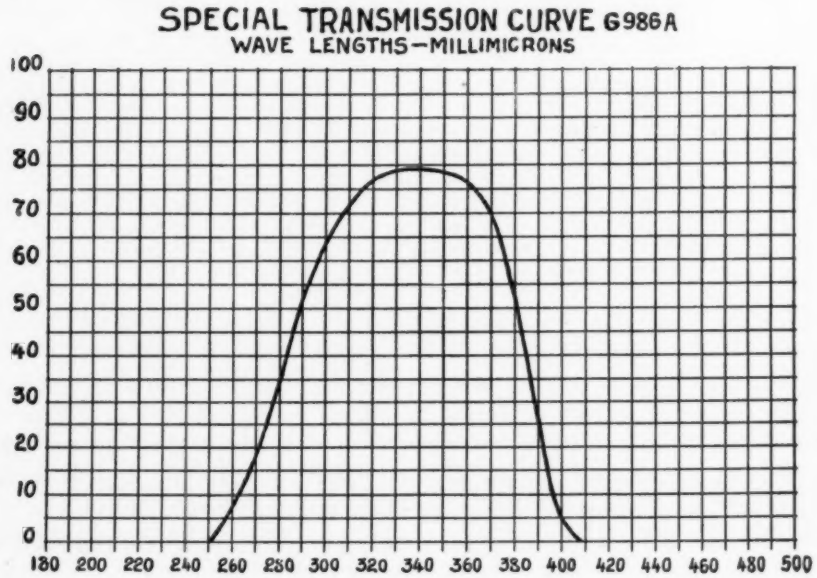

FIG. 2

A large loop-full of tubercle bacilli was taken from a three-weeks' culture of H37 grown on glycerin agar and ground in a mortar with increasing amounts of sterile saline up to eight cubic centimeters. When the clumps had all been successfully broken up, five drops of this cloudy suspension was added to five cubic centimeters of saline, giving it a consistency such that the point of a lead pencil was just faintly visible through

the test-tube. Each animal was inoculated with five-tenths of a cubic centimeter of the latter suspension. Three animals were used for controls and three were irradiated. The animals were irradiated in small oblong boxes, painted black on the inside, to avoid reflection of light.

Irradiation was begun two weeks after inoculation with the organism. One side of the box was removable and replaceable by the glass filter so that the animal was exposed, moving around within the box. There were no dark corners in the box which could not be reached directly by the light. The animals were irradiated daily at a distance of one meter, beginning with five minutes. The time was increased up to thirty minutes and the distance gradually decreased to thirty centimeters. All the pigs had previously been shaved. All animals were allowed to die naturally and autopsies were performed to observe the distribution and character of the lesions. Histological sections were made of all organs removed at autopsy and stained with hematoxylin and eosin. The progress of the animals was followed by means of weight charts (Fig. 3). The duration of life of the animals after treatment, in days, is given.

CHART I

WEEKLY WEIGHT IN GRAMS

Group I *Untreated*			Group II *Treated*		
#1	#2	#3	#4	#5	#6
270	260	270	390	270	260
290	290	300	408	290	280
*290	290	310	400	290	290
290	290	285	350	265	290
260	300	285	350	260	290
245	300	280	350	240	285
210		280	350	225	280
			350	220	260
			350	200	255
				190	250

* Injected with H37 tubercle bacilli.

CHART II

DURATION OF LIFE AFTER INJECTION (IN DAYS)

Group I *Untreated*		Group II *Treated*	
Pig	Days	Pig	Days
#1	41	#4	50
#2	32	#5	59
#3	48	#6	65
Average	40		58

FIG. 3

Microscopic study of the histological sections of the organs removed at autopsy showed definite differences in the lesions of the pigs in Group I and Group II. The lesions throughout were uniformly of the exudative type. In the Group II animals, there were areas of caseation and necrosis, as in Group I, but there was a decided attempt at organization. Young fibroblasts were seen growing in from the periphery. There was also a definite attempt at giant-cell formation. Some mitotic figures were also seen, indicative of the general trend of a regenerative process. In the first group, however, in the untreated animals, there were areas of central necrosis and caseation but no attempts whatever at regeneration.

Discussion. The results of the work carried out thus far bring up several important questions. As was seen in the clinical series, the healing of the sinuses was the most outstanding result. Some of these sinuses

had been in existence for months and years before treatment was instituted. Others were of comparatively recent origin. None were treated directly, yet all healed. In several of the cases the régime had been the same, exclusive of the heliotherapy, for several months; that is to say, the patient had been in the hospital on the same diet and under the same environment without any change occurring in the sinus. No other form of treatment was added except heliotherapy. The effect of the light must, therefore, have been a general effect. It is yet to be determined whether this effect is a specific one for tuberculous sinuses or a general wound-healing phenomenon. Further experiments are in progress to determine this point. In any case, healing tends to the preservation of function.

However, while this healing effect was the most outstanding result, a study of the cases shows that in many of them the tuberculosis was arrested or diminished very markedly. The results obtained in the small series of animals also bears this out. In this series, the visible rays were also excluded from the source of radiation. There was nothing but the band lying between 320 and 400 millimicrons and, of course, the infra-red at the other end of the spectrum, which reached the animal.

If this band of light is to be produced artificially, the best source is the carbon arc, using a carbon in which the ultraviolet below 300 millimicrons is absent or nearly absent. If this short ultraviolet band is present to any marked degree, the dosage necessary to give a sufficient quantity of light between 320 and 380 millimicrons, will be so long that the specific effect of the short rays will mask those in the desired region of the spectrum. There will be an alteration of the metabolism of calcium and phosphorus and the rays between 280 and 310 millimicrons will produce sufficient erythema to prevent sufficiently long radiation. It is the rays between 300 and 320 millimicrons which are most effective in the production of a tan, and also of erythema. Dosage has been measured by the development of an erythema. If, however, these erythema-producing rays are absent or very nearly absent, the dosage can be carried considerably beyond that which would produce an erythema, were they present. The quartz mercury vapor arc, while of great value in the treatment of rickets and calcium metabolism disturbances, is very rich in these short ultraviolet rays and comparatively poor in rays of the length of 350 millimicrons. It is true there is a very definite band in the region of 370 to 375 millimicrons, but treatment by this band is made difficult in this form of light by the presence of erythema and tan-producing rays around 300 millimicrons. It would seem, therefore, that the quartz mercury vapor light is not the most desirable type of artificial radiation for the production of the band under consideration.

CONCLUSIONS

1. Definite evidence of specificity of action occurs throughout the spectrum.

2. The wave-length band lying between 320 and 380 millimicrons has been studied both clinically and experimentally.

3. Effects have been obtained which prove this band to be active.

4. The chief effect is an acceleration of the processes of repair which may or may not be specific for tuberculosis, but which is essential in the retention of function. It is an indirect effect, general rather than local.

5. The band between 320 and 380 millimicrons is found in all sunlight and in carbon arcs of twenty-five amperes or more using a carbon of known spectral distribution.

6. Heliotherapy in tuberculosis can be as effectively carried out in sea-level cities as elsewhere.

7. Longer exposures can be given if the erythema and tan-producing rays, 300 to 320 millimicrons, are of small quantity or absent.

8. Erythema and tan therefore are of no use as a basis of dosage given.

9. Dosage should be measured in all sun therapy, and the method of measuring such dosage is outlined.

10. Artificial sources of light containing the band between 320 and 380 millimicrons and comparatively free from the shorter wave lengths are very useful as sun substitutes.

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CARBON-ARC-LIGHT TREATMENT IN BONE AND JOINT TUBERCULOSIS

Observations on the Methods and Immediate Results of Treatment with the High Intensity Carbon Arc Light in Tuberculosis of the Bones and Joints*

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This study was made at the Children's Hospital School, Baltimore, Md., during the winter and spring of 1928–1929.

From late October until the middle of April, Baltimore has so little sunshine and so much wind that the use of heliotherapy during this period is not satisfactory. During these winter months the children with surgical tuberculosis tend to slip backward or to come to a standstill in their general progress toward health. To do away with this annual set-back the quartz-mercury-vapor lamp had been tried, but with little or no success.

In the fall of 1928 a powerful carbon-arc light, the gift of Mrs. Louise Bowles, was installed on one of the wards. Twenty-two children with bone and joint tuberculosis were treated throughout the winter and spring. Their weights and blood counts were taken at monthly intervals and x-rays were taken every three months.

While the results obtained in one season in a small series of cases can seldom be considered proof of the value of any given therapeutic measure, we feel that our results were favorable, and are publishing them in some detail, hoping that others will do likewise, so that in the course of time there will be sufficient data available to permit an accurate estimation of the value of carbon-arc-light therapy in bone and joint tuberculosis.

We used a combination of the National Carbon Company's National CC White Flame Cored Carbons and National Orotip Cored Projector Carbons in the Schwartz High Intensity Carbon Arc Light. The lamp was run on alternating current.

It is not within the scope of this paper to discuss the spectrum of the carbon arc, or the relative value of different portions of the spectrum, or to compare the therapeutic value of the carbon-arc radiations with those from other lamps or from the sun itself. The reader is referred to the abundant literature on these subjects.

Our lamp was installed on one of the regular wards, a rather low room with casement windows on two sides. We found this room rather difficult to ventilate satisfactorily, and would suggest that whenever possible a sky-

*This work was made possible by the Louise Bowles Fellowship and was done under the direction of Dr. William S. Baer.

light or other ventilating device be placed over the lamp to carry off the heat and fumes from the arcs. An arrangement whereby the windows could be opened at the top without opening them at the bottom would also be helpful.

As the lamp was to be run only once a day it was necessary to make room for as many children as possible at one time. Most of the children were already on Bradford frames on their beds. By using wooden racks which would hold three or four frames each, in a sloping position, we were able to accommodate nearly twice as many as could have been cared for on their beds. The racks were wheeled into the ward when the treatment was to be given; the children, on their frames, were lifted from their beds to the racks and the racks arranged about the light. Our lamp hung seven and a half feet from the floor and we used a circle sixteen feet in diameter. The racks were sloped at such an angle that the rays coming off at right angles from the arcs fell upon the children at approximately the level of the umbilicus. Our amperage averaged eighty-five to ninety for the treatment period.

The children wore only diapers and such straps as were necessary to keep them from slipping on the sloping frames. Their eyes were protected by goggles of the type worn by welders, with very dark amber lenses. The light amber goggles used ordinarily for the mercury vapor lamp do not afford adequate protection against the intense visible light given off by the flaming carbon arc.

The initial exposure to the light was one-half minute to the anterior surface of the legs. This was merely a trial dose as we were using the apparatus for the first time. Since no erythema followed this exposure, we started next day on the regular schedule. The first day the entire body was exposed for one minute on the anterior surface and one minute on the posterior surface. This dosage was increased daily one-half minute on each side, a total increase of one minute a day, until the maximum dose of fifteen minutes front and fifteen minutes back was given. This maximum dose was continued thereafter unless a child had missed several treatments. When this occurred, the time of exposure on resumption of treatment was reduced according to the time lost, the condition of the child, and the amount of pigmentation still present. Each child received five exposures a week.

Children were not treated when they had an acute illness, a gastro-intestinal disturbance, or a temperature of over 100 degrees, unless the cause of the fever was known and was not considered a contraindication. It is obvious that after a short time there would be children who did not receive the same dosage as the general group. We met this problem by covering the child with a blanket when his time was up and leaving him on the racks, covered, through the rest of the period. The method was simple, and was entirely satisfactory during cool weather.

The children enjoyed the treatments, seeming to develop a sense of well-being under the light. In fact, by the middle of the winter one of our

greatest problems was to keep their activities, while on the racks, within safe bounds.

The ward was unheated, but, on all but the very coldest days, as soon as the light was turned on, the children's bodies became warm to touch from the radiant heat. They sometimes complained of cold feet. This could doubtless be obviated by an improvement in the method of ventilation, as mentioned above, or by building the racks so that the children's feet would be six or eight inches from the floor. The latter, of course, would necessitate a corresponding elevation of the lamp.

So much has been written regarding individualization in light treatment that it needs only to be mentioned here. The schedule of treatment already outlined seems to be safe for group treatment at the distance and with the current we were using. We did, however, have one case of erythema, showing that the program was not an overcautious one. On the other hand, there were doubtless a number of the darker skinned children who could, with safety, have been pushed ahead more rapidly, had we cared to do so.

There were twenty-two children who received treatment for at least five months. These twenty-two cases were used for the following study.

All of the blood counts were taken by our technician, Miss Elizabeth Knight, and, with the exception of a few of the earlier differentials, were counted by her. This rules out the factor of individual variations in technique. The blood counts cover the period from November 28 to April 30.

As we were interested primarily in the end result of the winter's treatment, we have chosen to compare the first and last counts made, disregarding the intermediate variations. In one case, where the last count was taken during an acute condition in no way associated with the effects of the light treatment, we have used the preceding count.

Chart 1 shows the changes in hemoglobin in relation to the original values. It will be noted that the increase was greater, the lower the hemoglobin in the beginning.

CHART 1

Hemoglobin at beginning	Increased		Decreased		No change
	No. of cases	Average increase	No. of cases	Average decrease	
Below 80%	3	9%	1	6%	0
80%	10	7.7%	0	0	0
Above 80%	5	4.2%	1	2%	2

Chart 2 shows the changes in the red-cell count. Here the figures, at first thought, do not look so promising, there being eight cases in which the red count dropped. It will be observed, however, that not one of these

eight children was anaemic to begin with. In only two cases did the count drop below 4,000,000.

In the red counts, as in the hemoglobins, we see the greatest improvement in those cases where the count was lowest to begin with. One cannot help feeling that the light acts, not as a mere stimulator of the blood-forming tissues, but as a force tending to restore the activity of these tissues to a normal level.

CHART 2

R.B.C. at beginning	Increased		Decreased		No change
	No. of cases	Average increase	No. of cases	Average decrease	
Below 3,900,000	6	306,666	0	0	0
Between 3,900,000 and 4,100,000	6	256,666	2	145,000	1
Above 4,100,000	1	150,000	6	165,666	0

A study of the total white counts shows nothing characteristic. The majority of the counts were within normal limits to begin with, and the variations from month to month no more than might be expected in any group of children.

No definite significance could be attached to the changes in the percentage of polymorphonuclear neutrophils. However, it may be of interest to note that, taking into consideration the average normal percentage for the age of each child, about twice as many counts moved toward the normal as moved away from it.

If we assume, as seems to be quite generally accepted, that an increase in the percentage of lymphocytes is a good prognostic sign in tuberculosis, then the changes in the lymphocyte counts are distinctly favorable. In our series fourteen children showed an average increase of eleven per cent., eight showed an average decrease of seven and four-tenths per cent. Of the eight falling counts, only four moved downward below the normal level for the age.

Summing up, it seems obvious that so far as the blood counts are concerned, this group of children showed a definite improvement.

The weights of the children were our next consideration. Four of the children were not weighed routinely, for reasons entirely apart from their condition. As all of them did well, two of them extremely well, during the winter, it is presumable that their inclusion would increase rather than

decrease the favorable aspect of our figures. Chart 3 shows the changes in weight among the other eighteen. One weight loss was obviously due to a tonsillectomy followed by a slow convalescence, for the child had regained and passed her previously stationary weight within a few more weeks.

CHART 3

Gained		No change	Lost
½ to 1¾ lbs.	2 to 4 lbs.		1 to 1½ lbs.
9	4	1	4

Ghormley states that in a group of cases of spinal tuberculosis treated by sunlight the year around, there was a tendency toward loss of weight during the months of least sunshine. Our children received no sunshine at all during the period of this study, yet they averaged a gain of nine-tenths of a pound for the period. And this rise was a steady one, not a sudden rise during the spring. Such a gain in weight, distinct, even though not large, during a period of the year when it is generally agreed that the weight of children with surgical tuberculosis tends to remain stationary or to drop, is significant. As these children, except for their exposure to the carbon arc light, received only the usual routine treatment of rest, fresh air, immobilization by traction, and simple surgical dressings, their improvement in nutrition must be ascribed to the effect of the light exposures.

Observations on the general appearance of the children agree with the more exact findings. The children became more animated, they made more noise, they ate better. One child of five, as her general condition improved, lost a very bad stammer and her temper tantrums decreased noticeably in frequency and severity. The most striking improvement occurred in a boy of twelve, who changed from a white, pasty-colored, rather fat but flabby child into a rosy-cheeked, firm-fleshed, bright-eyed boy. It is very difficult, of course, to give figures in a matter in which one deals with general impressions and in which the borderlines between groups cannot be sharply drawn. Roughly, about nine children showed rather striking improvement, ten were in excellent condition to begin with and remained so. One small boy went down hill the first two months, but picked up again and reached or passed his original status. One child showed no change in condition, and one, after seeming to improve for a time, went rapidly down hill.

If we group the blood count, weight, and appearance of each child, in an attempt to estimate the actual change in their general condition, we find sixteen showing definite improvement, three slight improvement, two little or no change, and one an ultimate change for the worse. Surely an

excellent showing, for the season of the year was the one traditionally dreaded by those caring for children with surgical tuberculosis.

Our x-ray pictures, taken by Dr. Marcus Schwartz, the resident of the hospital, cover a slightly longer period than the blood counts and weights, the third set having been taken between the middle of May and the third of June. May was a cold, cloudy month and the children received treatment with the carbon arc light throughout the month. These x-rays show a very gratifying improvement in the affected bones. This improvement consists of an increased deposition of lime salts, a sharpening of detail in the bony parts, and, in the spinal cases, an absorption of the destroyed vertebral bodies and a fusing together of the vertebral bodies adjacent to them. Chart 4 shows the changes in the bony lesions as disclosed by the x-ray.

CHART 4

Improved	Unchanged	Worse	Insufficient data
17	0	2	3

In many cases, of course, the children were on the upgrade when the treatment was begun and the improvement was only a continuation of that already under way. However, that these children, during the most trying part of the year, continued to overcome the tuberculous process, seems to us a favorable showing. In two instances, a hip and a knee, the pictures taken at the beginning of treatment, compared with earlier ones, showed the destructive process still advancing, while the midwinter pictures showed it not only arrested, but already in the process of healing.

We are fortunate, in the matter of evaluating our x-ray findings, in that we have a group of seven children who did not have light treatments, but who did have x-rays taken at times corresponding very closely to the times of the x-rays taken for this study. These children were quite comparable to those who were treated, so far as their condition was concerned. They were omitted from the treatments,—in two cases because they were in casts following operation, in one case because the child's condition was so good that radiation did not seem indicated, and in the other four because we did not have room under the light for all our cases of tuberculosis and these four were on the most distant ward. While the x-rays showed some improvement in all these cases, especially in the matter of fusion, in only one case did it approximate the progress made by eighty-five per cent. of the children exposed to the light. These findings support our view that the light was a definite factor in the favorable progress of the children who received treatment with carbon-arc radiations.

Comparison of our x-ray and clinical findings shows a close agreement. Sixteen children improved in both their tuberculous lesions and their

general condition. One child was in such excellent general condition from the beginning that no improvement could be looked for on that score. Her local condition improved. In only two cases did the x-rays show an advance in the local disease,—the general condition improving in one, and standing still in the other. In the other three, adequate x-ray data were lacking.

We have presented the results of our study and our interpretation of the findings. There remain certain questions and problems which arose during the course of this study which, we believe, are of sufficient interest to be included in this paper.

It was noted that in eight, or about one-third of our cases, there was a rapid rise in the blood count during the first six or seven weeks, followed by a sharp drop. Why should this drop have occurred? In one instance an attack of grippe shortly before the low count was taken is the probable explanation, as the next count showed that the lost ground had been more than regained. In the other seven no cause for the drop could be ascertained; nor could these children be grouped in any way. They varied in age; some were dark, some fair; some had sinuses, some did not. The high blood level occurred toward the end of January, when the children were just beginning to receive the maximum dosage. One wonders whether continuous treatment with this amount of radiation may not have been just above the optimum for them, and whether they might not have shown a greater ultimate improvement under a smaller dosage. Only the child with grippe ever quite regained that first high level.

The dosage we employed was worked out, for the most part, on adults. It may be that to get the best results in children some modification will be necessary. Only experimentation can determine this point.

Another query which arose was as to whether there was any difference in response to treatment between the blondes and the brunettes. We had eight definite blondes, five brunettes, eight of medium coloring, and one negro. Most of the children in whom improvement in general condition was slight or lacking were blondes or near blondes. The brunettes all did well, as did the negro. The two children whose local lesions became worse were blonde and near blonde. On the other hand, the blonde group had more than its proportionate share of children whose local lesions did especially well. Apparently blonde children do not respond as well to carbon-arc-light therapy as do brunettes, especially with regard to their general condition. It would be interesting to know whether, in blonde children who received no light therapy of any sort, the general condition showed the same lag behind the local condition in the process of recovery.

Regarding the effect of the light treatment on the sinuses we can say very little. One sinus healed while under treatment and has remained healed. This sinus was never directly exposed to the light. We did expose three sinuses to direct radiation. None of them healed, though the amount of drainage decreased in two. The really striking result of these exposures was the improvement in the condition of the surrounding skin.

After a very few exposures there was no further irritation around the sinuses, and in time the tolerance for adhesive plaster was greatly increased.

Certain of the questions that arose concerned what one might call the technique of the treatments.

It was impossible to continue traction while the children were on the racks. Would the release of traction for about forty-five minutes five times a week be harmful? Our x-rays seem to show that it was not.

Another question was, what to do with children in hyperextension on bent frames when they were turned on their abdomens for exposure of their backs. This problem the children solved themselves. If their shoulders were left free they immediately raised their heads and shoulders to look around and so produced a hyperextension of the entire back that could not have been bettered. On the few occasions when their interest in the environment flagged, a rolled up nightgown or blanket tucked under their chests kept them in reasonably good position. It was not possible to use the bent frame turned over, as can be done on a bed; it was too unsteady on the rack.

It might be well to discuss very briefly the two cases in which the children failed to gain in any way under light therapy. One of these children, a girl of twelve, had a tuberculosis of the sacrum with multiple sinuses in the left thigh. She had been running a septic temperature for months before the light treatments were started. She had a one plus albumin in the urine, without casts. For three months after the treatments were begun she seemed to show some gradual improvement, except in her blood count. In March the urine suddenly showed four plus albumin. It was rather scanty in amount, of high specific gravity, with no casts or red blood cells. There was no oedema. At this time she had been having direct exposures of her sinuses for about four weeks. These were discontinued but the general light baths were not stopped. The albumin decreased somewhat. Finally, however, in April, she developed diarrhoea, then general oedema, then an ascites. She died in July. There was no autopsy. What rôle did the light treatments play in the history of this case? Probably none in the ultimate outcome. Whether it hastened or delayed it there seems no way to determine until careful studies have been made on a considerable number of such cases, and on their reaction to light exposures.

The other child who failed to show improvement had a rather acute tuberculosis of the hip. She had an attack of grippe in early January, from which she recovered very slowly. This probably accounts in large part for her failure to improve and for the increase in the tuberculous process. The child has no sinus, she is not anaemic, she has stopped losing weight. There seems little reason to doubt that she will ultimately make a satisfactory recovery.

To discuss the question as to why children improve under light therapy is outside the scope of this paper. We can only refer the reader to the literature on the physiological effects of light, leaving him to make his own choice among the theories that have been presented.

SUMMARY

1. Twenty-two children with bone and joint tuberculosis were treated throughout the winter and spring with radiations from a high intensity carbon arc light.

2. In the majority of cases the blood counts rose under treatment. Our figures support the theory that the effect of the light upon the blood-forming tissues is a restoration of normal function, not a mere stimulation.

3. The children tended to gain weight while under treatment.

4. The favorable effect upon the local tuberculous lesion was marked.

5. We believe that our findings show that exposures to the radiations of the high intensity carbon-arc light are of value in the treatment of bone and joint tuberculosis, especially during those months when little sunlight is available.

6. While the value of this form of treatment seems to be well established, many problems connected with its use remain to be solved.

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CONTRIBUTION TO THE PATHOGENY OF TENDON TUMORS OF GIANT CELLS

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Tendon neoplasms are quite rare and their study arouses a certain interest. At present tumors of giant cells are the subject of many varied and interesting discussions. The opinions expressed concerning the origin and meaning of these cells are quite contradictory. Moreover, in the myeloplaxomas which lie on tendons and tendon sheaths, there appear other elements, such as lipoid cells, cholesterin crystals, and osteoid tissue; and the presence of these has caused many divergent interpretations.

In the first place, there is a decided tendency to regard these tumors as inflammatory processes. Sometimes they are given an infectious etiology; again the etiological factor may be considered an irritating traumatic action; and finally, by some these inflammatory tumors are considered due exclusively to unbalanced metabolism.

Favre states that syphilis often causes infiltrations and accompanying neoformations which are very difficult to distinguish from true sarcoma of the myeloplaxes. Histologically they could only be differentiated because in the true sarcoma the vessels are lacunar, while in the false sarcoma they are fine; and because in the surrounding fields, the false sarcoma presents very dissimilar histological pictures.

These statements of Favre seem hardly convincing to us. In true sarcoma the vessels are not always lacunar and the appearance of the same varies in some cases in the most decided manner. Moreover, the giant cells of the granuloma can be well differentiated from the true myeloplaxes. The nuclei of the latter tend to form central groupings, while in the inflammatory giant cells they frequently leave free the center of the cell and form a peripheral crown.

Lècene and Moulonguet are of the opinion that the origin of the inflammatory granuloma is due to a repeated traumatism. They find a close analogy between the histopathology of these tumors and that of some chronic bursites and that of hemorrhagic pachyvaginalitis.

Broders believes that quite possibly the origin of these tumors with which we are dealing lies in a sanguineous extravasation following a traumatism or an infection. Janik definitely concludes that tumors of giant cells in the tendons and their sheaths are caused by trauma or irritation, that they are inflammatory granulomas, and they should be excluded from the group of the neoplasms.

A third group of authors regard the formation of these neoplasms as due to an unbalanced metabolism of the lipoids, principally that of the

cholesterin. That is to say, they consider them as tumors similar to cutaneous xanthoma. These suppositions seem to rest on very sound reasons. One reason is the presence of an abundant quantity of lipoids within certain elements of the tumor and in intercellular spaces, as well as the presence of cholesterin crystals in certain zones. The second reason is the hypercholesterinaemia observed in some cases. Knowles and Fisher have gathered a series of cases of this nature, in which the xanthomatous lesions were multiple and localized all over the body. This general involvement seems to demand the acceptance of the theory of the origin as a metabolic imbalance as equally distributed. These authors also call attention to the cases where the imbalance is of a familiar nature.

McWhorter and Weeks state that these tumors, like all the varieties of xanthoma described are the result of a systemic disease, of which hypercholesterinaemia is the essential characteristic. The composite elements of the tumor are then the results of the reaction caused by the deposit of cholesterin. The case studied by these authors presented multiple tumors in several tendons: finger extensors, rotular, Achilles tendon, etc. Repeated determinations of the cholesterin in the blood always gave ratios higher than the normal.

Kusnetzowsky in his study of a similar case believes that he is dealing with an inflammatory process produced by local deposits of cholesterin, caused by a metabolic imbalance of the lipoids. But these can only take place in fields especially predisposed, such as the tendon sheaths formed by long connective fibers and analogous to the way in which deposits of cholesterin are secondarily formed in the vessels of the arteriosclerotic. In his opinion the part played by the lipoid cells in the histology and the physiopathology of these tumors remains without explanation.

Silberberg maintains that even if it is true that sometimes the imbalance of lipoid metabolism may cause a secondary xanthelasma, there are xanthomatous tumors without metabolic disturbance. In such tumors the lipoid cells constitute one of the various elements which enter into the formation of a mixed tumor, which was formed from several neighboring tissues, each acquiring greater or lesser preponderance in the development of the neoplasm.

Silberberg's opinion confirms the statements made concerning the nature of these tumors by the first authors who studied them: Krogius, Heurteaux, Gourneur, etc. These writers thought that without any doubt they were true blastomatous formations. Zeyland and Dega have studied the lipoid cells present in cystic osteitis fibrosa and they regard them as secondary elements superimposed on the lesions of this disease, and due to a hypercholesterinaemia or to a local cholesterosis.

Ewing, too, had inferred this local metabolic disturbance. In the case studied by Zeyland and Dega the amount of cholesterin in the blood was 274 milligrams per 100 cubic centimeters. These men believe that hypercholesterinaemia alone is not sufficient to cause a xanthomatous tumor, but that trauma and repeated hemorrhage are necessary to bring it about.

Harbitz agrees that these tumors are true neoplasms, even though he believes that in certain stages of altered metabolism, xanthomatous formations are produced. Vermooten, too, has studied a case of tumor of giant cells with lipoid cells developed in the thumb, but he does not discuss its pathogeny.

In Spain, Segovia and Llompart have studied two cases of tumors of tendon sheaths in the hand flexors. In one of them they found all the elements typical of these tumors: undifferentiated cells, myeloplaxes, lipoid cells frankly macrophagic, and connective tissue. In the other case they made a very interesting discovery: namely, that the connective tissue is arranged in certain zones forming trabeculae analogous to those of the spongy osseous tissue, either without calcification, or in some spots with a beginning of calcification. Moreover, in these zones they found by the side of the myeloplaxes, osteoblastic elements which undoubtedly caused the rudimentary osseous formation. The existence of these associated elements already differentiated, side by side with the undifferentiated sarcomatous cells, allows, in the first place, the interpretation of the giant cells as myeloplaxes and, in the second place, it confirms the neoplastic nature of these tumors, inasmuch as it is logical to attribute an identical origin to elements of the same family grouped in a tumor. It is to be noted, too, that in one of the cases studied by these authors, where there were no lipoid cells, there were also no accumulations of cholesterin.

Personally we have recently studied the following case:

FIG. 1

A man thirty-six years old, well formed and without history of specific or hereditary disease of any kind. Twenty-three years ago he began to notice a lump in the right knee, and he supposed it to be caused by a blow received at some time. The growth was so slow that the patient hardly noticed it; until very recently it had not bothered him at all. Now it hurt him a little when kneeling down and at a change of weather.

By examination and palpation it appeared to be a hard tumor about the size of a hen's egg, lying under the patella and in front of the patellar ligament. It was not sensitive to moderate pressure. The radiograph of the knee shows absolute normality in the joint. There was no decalcification.

The determination of cholesterin in the blood, made by Prof. Negrin, showed 179 milligrams per 100 cubic centimeters, that is to say, it was within the normal.

Operation.—Transverse incision on the head of the tumor. It appeared well encapsuled, but as it enveloped the patellar ligament completely, it was necessary to incise the tumor from the inside in order to dissect the tendon and to completely enucleate

the neoplasm. Figure 1 shows a sagittal cut of the articulation and it shows plainly the macroscopic structure of the tumor. The articulation was not opened. The tumor rested on the lining made by the aponeurotic expansion of the quadriceps on the patellar ligament. The postoperative course was normal.

STUDY OF THE TUMOR

Macroscopically the tumor was an irregular mass about the size of a mandarin orange with a well defined fibrous capsule. The surface was smooth. When cut, it was mostly of yellowish color with a few spots almost white in color. In the yellowish mass forming the greater part of the tumor appeared some small islets dark brown in color. These islets formed an irregular dotting spread on the yellowish surface of the tumor cut.

The histological examination was made according to the teachings and observations of Dr. Rio-Hortega and following his staining technique with silver carbonate.

The neoplasm had a cover composed of dense fibers in the network of which one could see quite a few nuclei. This cover of fibrous tissue surrounded the free areas of the tumor. The central mass of the latter was formed mainly by sarcomatous cells, or cells of sarcomatous appearance. Their size varied from twenty-five to thirty microns. Some were round and others fusiform. Likewise their nuclei were round or oval in shape. In some fields the microscopic picture was that of a true fibrosarcoma (Fig. 2). In other zones, in the midst of small-sized cells appeared others somewhat larger. These elements which we have just described were found very evenly distributed, constituting the greater part of the tumor. The other elements included were found grouped in certain places, leaving large sections of the sarcomatous mass entirely free of them. These elements so unevenly distributed were the giant cells and the so called lipoid cells or foamy cells.

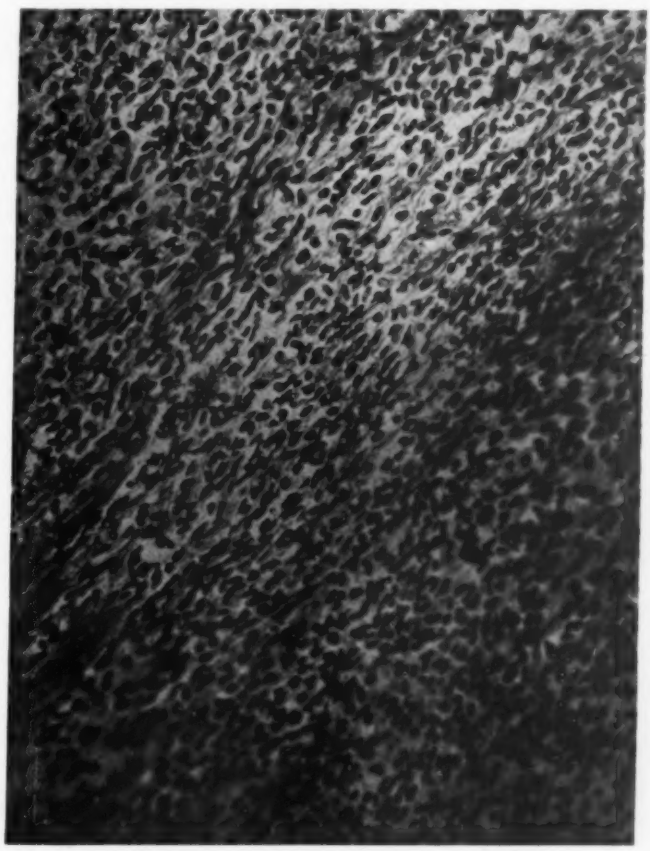


FIG. 2

The giant cells in the tumor were of all sizes, from some small measuring forty microns to some very large which measured more than 100 microns. The number of nuclei among these cells also varied within very broad limits. In Figure 3, we see a

FIG. 4

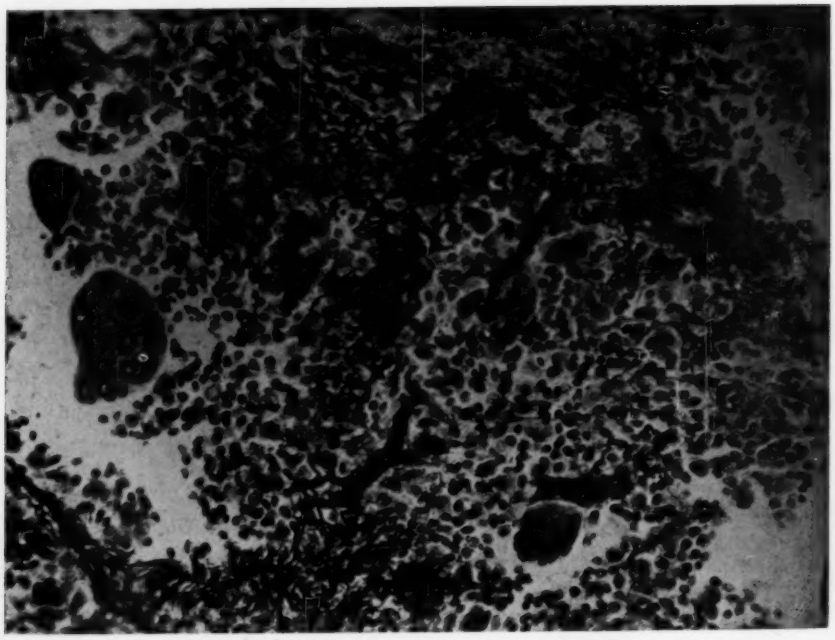
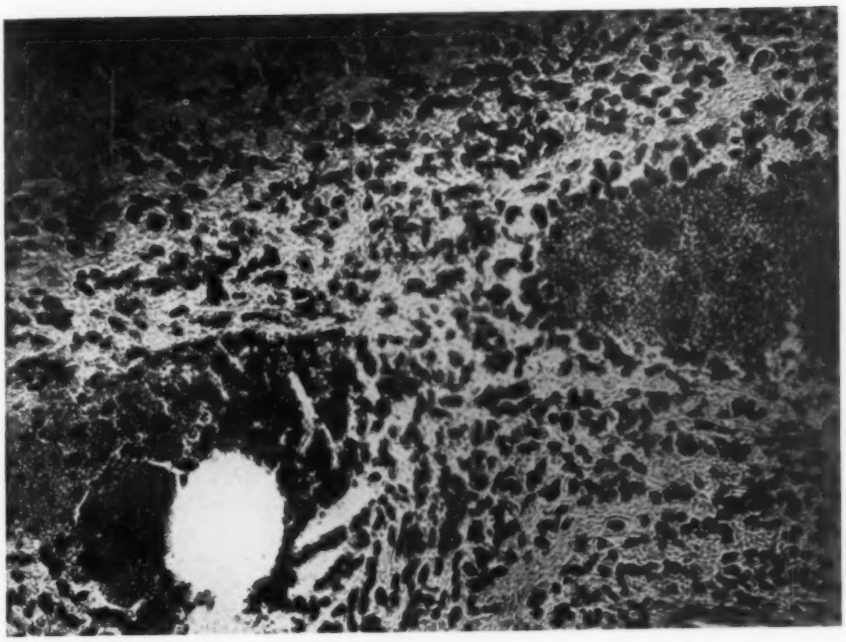


FIG. 3



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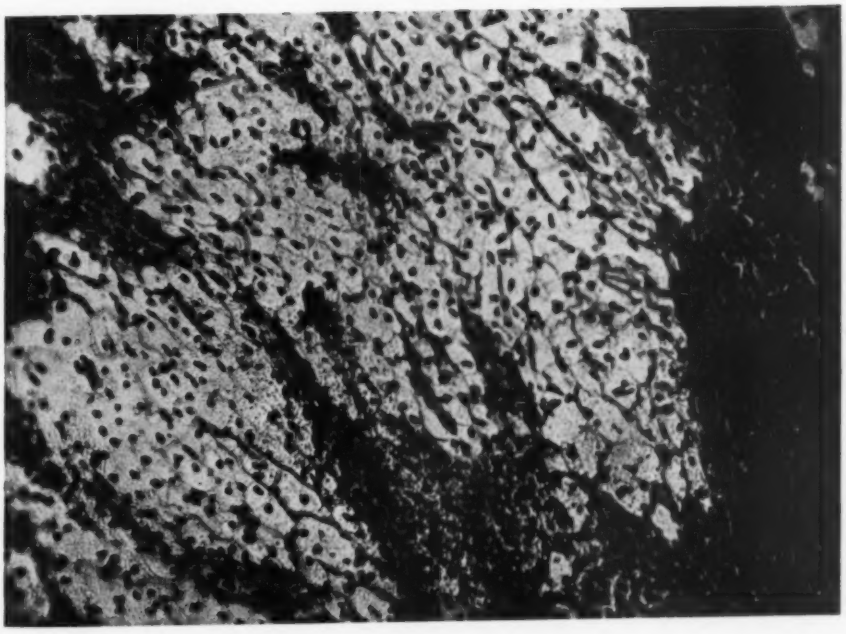

FIG. 5

FIG. 4

FIG. 3

myeloplax which contains about 100 nuclei. In Figures 3 and 4 we can judge the different shapes and sizes of these elements. Their distribution, as we have noted above, is uneven. They are generally grouped in certain zones and sometimes many zones may be examined without finding any.

With the use of our preparations, we have always found the lipoid cells. They are grouped, forming islets more or less large in the proximity of the fibrous cover limiting the tumor. They are elements of abundant protoplasm and small nuclei. When using preparations dyed following the common technique, we can detect in the protoplasm only a slight vacuolization which gives the foamy appearance characteristic of these elements (Fig. 5). When a complementary solution was used with Sudan, we noticed fatty sediments in the interior. We found also cells with inclusions giving the iron reaction.

The Sudan stain shows the existence of large quantities of fats all over the tumor, while in some places it gathers considerable accumulations (Fig. 6). Almost all the elements in the tumor accumulate fats and only the myeloplaxes seem freer from them. Nevertheless, we have seen some of these cells in decided fatty degeneration.

A very interesting zone in the tumor is the one where there are crystals, apparently of cholesterin. We were not able to observe the crystals themselves in the sections, but the zones where they were deposited preserve some typical traces which may be noticed in Figure 7. Around these zones we do not often find myeloplaxes, but we do frequently find nearby foamy cells.

The connective tissue is abundant all over the tumor. Saturation by heat with carbonate of silver shows the formation of a broad network of collagenic fibers not very fine, distributed throughout the neoplasm. In certain places it assumes great density. Among its fibers there are well tinted nuclei (Fig. 8).

The study of this patient and the excised tumor render it possible for us to make the following comments. In the first place, neither the history of the case nor the histopathology of the tumor allows us to consider it as a false sarcoma in the sense that Favre might. We cannot

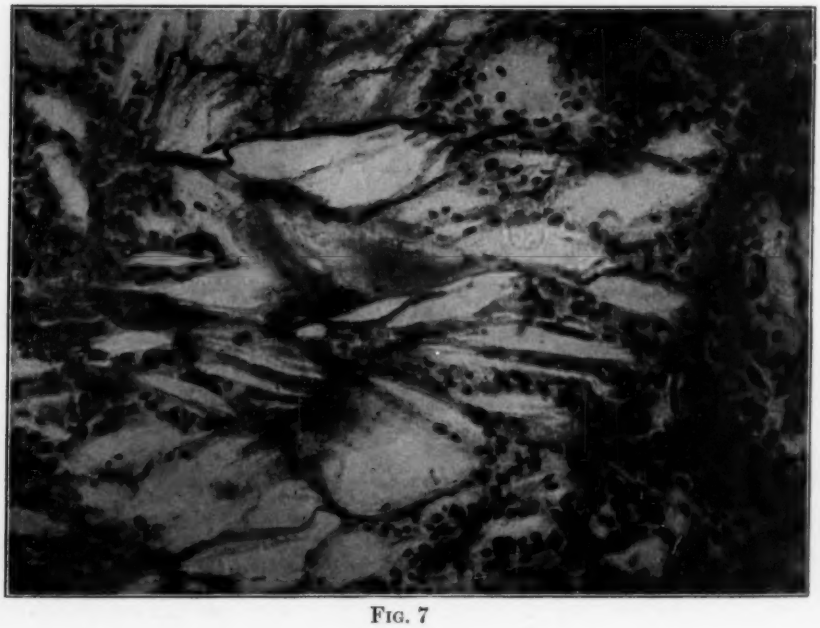

FIG. 7

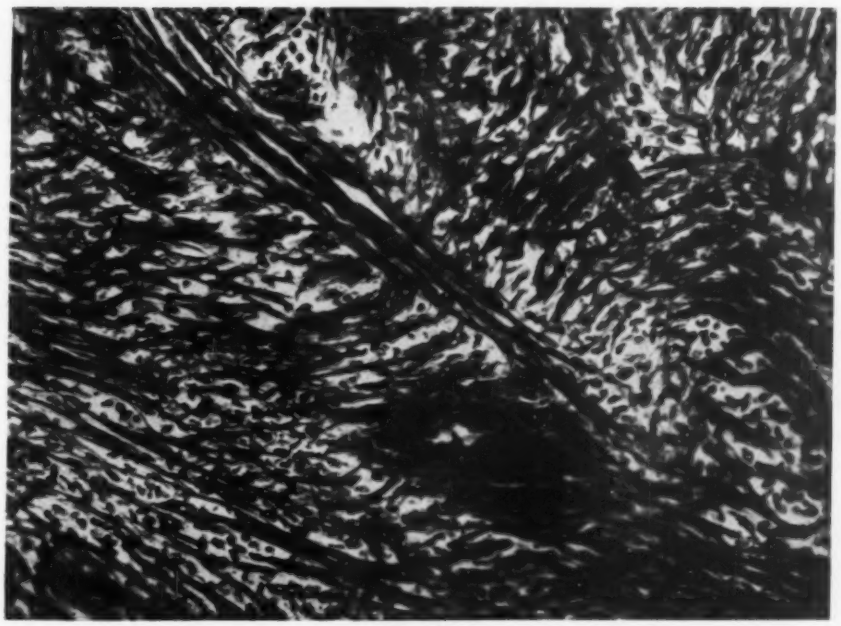

FIG. 8

admit that we are dealing with an infectious granuloma either tuberculous or syphilitic.

The action of a repeated traumatism such as is accepted by Lècene and Moulonguet cannot be applied to the etiology and pathogeny of this tumor. Nor can we apply to this case the association of trauma, repeated hemorrhages, and hypercholesterinaemia that Zeyland and Dega consider necessary for the formation of a xanthomatous tumor. Not one of these factors existed in the tumor studied by us.

The absence of hypercholesterinaemia, together with the accumulation of cholesterin lipoids and cholesterin crystals in the mass of the tumor, is a very interesting phenomenon. As there was no general imbalance of the lipoid metabolism, it must be admitted that the presence of these elements in the tumors studied is due to functions or reactions inherent to the tumor and depending undoubtedly on the foamy cells. Segovia and Llompart, as well as the writer, have ascertained that these elements are true macrophages representing the reticulo-endothelial system in the tumor. This explains the reason why, in the cases where these elements are absent, as happened in one of the cases studied by the authors last quoted, the accumulations of cholesterin are also absent. The lipoid cells, as well as the accumulations of lipoids, are inconstant in tumors of giant cells; and we believe that when they are present they play a secondary part foreign to the etiology of the tumor.

These conclusions of ours partly coincide with those of Silberberg who believes that, while sometimes an unbalanced lipoid metabolism may cause a *secondary xanthelasma*, in other cases there exists the *xanthoblastome* as

part of a mixed tumor and with greater or lesser preponderance among the elements of such a mixed tumor.

There still remains to be explained how the accumulations of cholesterin have been produced, and this explanation has to be looked for in the physiology of the reticulo-endothelial system. The study of the functions of the latter permits us to conclude that the reticulo-endothelial cells serve both to produce cholesterin and to keep it in reserve. That is to say,—the foamy cells, when forming part of the tumor, add to it their cellular bodies as well as their functions,—as yet somewhat obscure.

The frequency of lipoid cells and accumulations of cholesterin in the giant-cell sarcoma which we are studying, depends on the localization of these tumors in tendon sheaths and in aponeuroses or aponeurotic expansions or extensions, which have, as is well known, abundant histocytes among their tissue.

CONCLUSION

We regard the giant cell tumors of the tendons and tendon sheaths as true blastomatous formations of well differentiated elements of osteoperiosteal and histocytitary origin. The said differentiation sometimes allows the formation of an osteoid tissue or at least of a connective tissue quite dense.

Local cholesterosis is a function of the reticulo-endothelial system which enters into the formation of the tumor. Hypercholesterinaemia which is an essential factor in the origin of the xanthoma is without importance in the tumor of giant cells.

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BONY FIXATION OF THE FOOT IN INFANTILE PARALYSIS: SUBASTRAGALAR ARTHRODESIS*

BY WALLACE H. COLE, M.D., ST. PAUL, MINN.

The stabilization of paralytic feet by arthrodesis of the subastragalar joints, performed with or without fusion of some of the adjacent accessory joints, has apparently become an almost universal procedure and, in at least some of the big clinical centers, such operations greatly outnumber the combined total of all other methods in the treatment of these feet. Since G. G. Davis first described the procedure, the literature has become full of reports dealing with various methods of performing the operation. It is not the object of this brief discussion to advocate the exclusive use of any one method, but merely to review some of the more common operations and attempt to show that all of them have their usefulness and that fundamentally they are very much the same and do not deviate from the basic principles of Davis. A preliminary report of 224 arthrodeses will be included in this discussion.

The primary indication for subastragalar arthrodesis is to make the wearing of apparatus unnecessary and secondarily to increase the function of the foot and with it that of the entire extremity. Skeletal fixation has proven to be so satisfactory that on reviewing the literature one is sometimes surprised at the amount of work which has been done in attempting to stabilize feet by operations on the soft parts alone. Fortunately the limitations of soft-part procedures used by themselves are now well understood and there should be no conflict between the indications for such operations and the arthrodeses. Astragalectomy, a stabilizing operation standing by itself, has, of course, a wide range of usefulness; and in discussing and advocating arthrodesis I do not want to belittle the Whitman operation in any way. There is a definite group of cases where it is the operation of choice; in my work it ranks near arthrodesis in importance, but is used in a more limited number of cases.

In traveling around to the larger clinics in the United States one is struck by the many ways which are being used to achieve proper position and bony fixation in paralytic feet. No two surgeons seem to use exactly the same technique although they can all show you perfect results as the final outcome of their operations. The reason for the similarity in results is that the same underlying principles are applied by all and the differences in technique are merely due to personal preferences and to the application of varying, but comparatively unimportant, minor details.

In all arthrodeses, by whatever method, there are two things to be accomplished in addition to the fixation and these are: first, proper rearrangement of the elements of the foot itself and second, proper placing

*Read in part at the Joint Meeting of the British and American Orthopaedic Associations, London, England, July 5, 1929.

of the foot in relation to the leg above it. Deformity must be corrected and the foot left in the neutral position. Lateral muscles, if not paralyzed, must be transplanted either to the Achilles tendon and os calcis or forward to the front of the foot, depending on the distribution of the paralysis, as inverting or everting forces are no longer necessary and may be actually detrimental to the final result. The neutral position of the foot on the leg depends largely on the degree and extent of the paralysis and in all of the more severe cases the element of posterior dislocation, as emphasized by Whitman in his astragalectomy, is all important. The necessity of obtaining correct alignment of the leg above the ankle by osteotomies and tibial turns frequently arises, but is not as vital a problem as suggested by some authors.

The indications for stabilization of a foot by subastragalar arthrodesis are many, but they can not be definitely set down as there are certain groups of cases where other procedures are of equal or greater value in the hands of certain operators. In general, all but the milder cases of muscle imbalance in older children or young adults should receive this treatment, combined with such procedures as bone block or muscle transplantation if necessary. In younger children with flail foot or calcaneus deformity, astragalectomy is frequently preferable, but certainly arthrodesis also gives excellent results in many cases. Although there is no doubt that, theoretically at least, the best results with arthrodesis are in individuals over fifteen years of age, perfect bony fixation can be obtained much earlier. The youngest cases in my series, two in number, were six and one-half years of age. Excellent feet both anatomically and functionally were obtained, with bony union between the astragalus and os calcis in each but, from the radiograph, apparently only fibrous union in the astragalo-scaphoid joints, due undoubtedly to insufficient operation. The average age in the series was eleven and one-half years and if clinical findings, plus

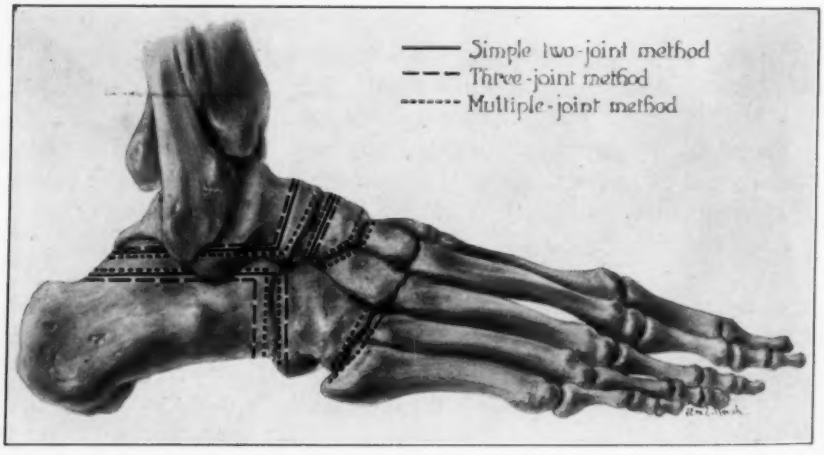

FIG. 1

Diagram showing character of three types of operations for stabilizing the paralytic foot.

FIG. 2

Diagram of result after simple two-joint type of arthrodesis. Note how posterior dislocation depends on the amount of bone removed at the astragaloscaphoid articulation. Original position of bones partially indicated by dotted line.

roentgenological examination in most cases, can be relied on, bony union took place in the subastralagar joint in all but two. In a few, where the astragaloscaphoid union seemed to be fibrous in early radiographs, later films show definite bony fixation. A few other cases, such as the two youngest ones just cited, still show a gap at this point, with probably fibrous union, but the clinical stability is firm. No case was operated upon, of course, until at least two years after the acute attack and all neglected cases were given the benefit of support and physiotherapy before operation was considered.

The original operation of Davis which plows up the adjacent articular

FIG. 3

Diagram of result after three-joint type of arthrodesis. Original position of bones partially indicated by dotted line.

surfaces of the astragalus, os calcis, and scaphoid by means of gouges, leaving all of the fragments in place but freeing the bones from each other so that the correct position can be obtained, is similar in principle to the more technical architectural stabilization of Hoke and is the basis for all of the subsequent arthrodesing operations which have been described in the literature. Davis himself refined his original technique and later performed more accurate operations and realized the importance of posterior dislocation. Recognizing the Davis principles as fundamental, it is still necessary to classify in some way the existing operations. This is extremely difficult, due to the varying techniques, but I have grouped my cases under three general heads; the Hoke, the two-joint, and the three-joint varieties. The latter includes a few multiple joint arthrodeses performed after the method of Ryerson. A brief description of these operations is necessary in order to make the classification clear.

The Hoke operation, a rather highly refined two-joint procedure, aims first at reshaping the astragalus so that the normal architecture of that bone and the mid-tarsal region is restored and second, at restoring the normal relationship of the os calcis to the astragalus and leg by proper excision of the true subastragalar joint. The first object is obtained by removing the head of the astragalus and reshaping it, so that when it is replaced between the neck and the denuded scaphoid it will keep the forefoot in proper alignment with the posterior tarsus. The hindfoot can be placed where desired after the os calcis has been loosened from the astragalus with cleaning out of the joint cartilages between, and any needed posterior dislocation can also be obtained. The degree of dislocation depends, of course, on the amount of bone removed from the neck of the astragalus and the scaphoid. Properly performed this operation of Hoke gives almost perfect results.

FIG. 4

Diagram showing character of bone incisions in Hoke type of arthrodesis.

In the three-joint operation the astragalocalcanean joint is so cleaned out that after removing the head and part of the neck of the astragalus and denuding the posterior surface of the scaphoid and the two surfaces of the calcaneocuboid joint, the entire foot can be displaced backward, the degree depending on the amount of bone removed from the neck and from the scaphoid, as in the Hoke operation. Sometimes the entire scaphoid is removed and the stump of the neck then must come against the denuded cuneiforms. Here again any lateral or calcaneus deformity can be corrected by the proper removal of bone from the astragalocalcanean joint and adduction relieved by removal of bone at the calcaneocuboid joint. Repeated emphasis must be placed on the necessity for removal of wedge-shaped portions of bone for the attainment of the neutral position in many feet.

The two-joint arthrodesis is similar to the three-joint in all respects except that the calcaneocuboid joint is not attacked, the operation confining itself to the astragalocalcanean and the astragaloscaphoid joints.

Ryerson's so called triple arthrodesis consists of denuding the cartilage from the astragalocalcanean joint, the astragaloscaphoid joint, and the calcaneocuboid joint through two lateral incisions with the removal of wedges where necessary but without any marked posterior displacement of the foot. Arthrodesis of the joints anterior to the cuboid and scaphoid are also sometimes performed and even of the joint anterior to the internal cuneiform. My experience with this method is very limited as the simple three-joint method accomplishes the same thing plus posterior dislocation of the foot and has therefore seemed more useful.

Dunn's operation for stabilizing the calcaneocavus foot by removal of a wedge from the mid-tarsal region and, through a second incision posteriorly, one from the astragalocalcanean joint accomplishes perfect fixation

FIG. 5

Diagram of result after Hoke type of arthrodesis showing remodeled astragalar head in position.

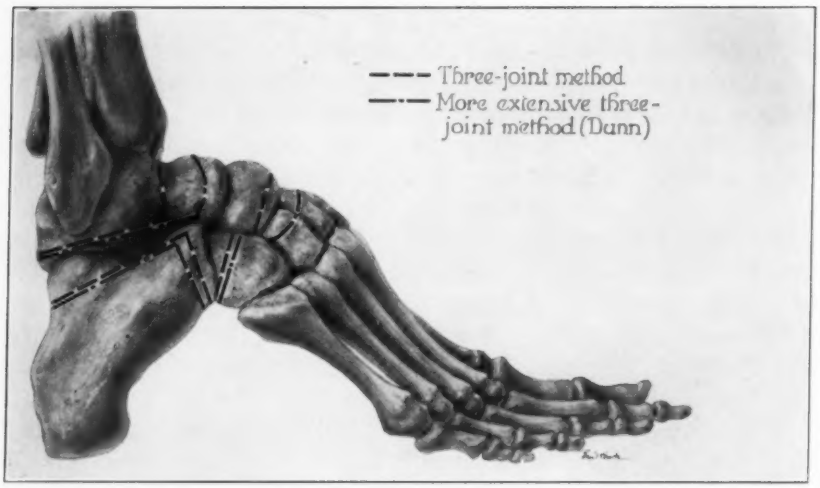

FIG. 6

Diagram showing character of bone incisions in two of the standard methods for stabilizing a foot with calcaneocavus deformity. It is seen that the method of Dunn can be classified as an extensive three-joint arthrodesis.

and excellent correction of the deformity in much the same way as in the ordinary three-joint procedure and can be classed with those cases. His operation for shortening the cavus foot necessitates the removal of the entire scaphoid and the adjacent articular surfaces, in addition to a large block of bone enclosing the calcaneocuboid joint. These procedures with freeing of the astragalocalcanean joint allow marked posterior displacement of the foot to a greater degree, perhaps, than is seen with the usual three-joint operation.

FIG. 7

Diagram of result after stabilization of a calcaneocavus foot by the three-joint method. Note similarity of end result to that in Fig. 8 where the Dunn type of arthrodesis has been performed.

Other arthrodesing operations in the foot include the panastragaloid arthrodesis, described by Albee and Steindler, in which the ankle joint and the subastragalar joints are destroyed, and the fixation of the astragaloscaphoid joint alone. The indications for these procedures are not common and time does not allow a discussion of them here.

The operative methods above outlined give in general the character of the work being done on paralytic feet in the field of arthrodesis. It seems fairly apparent that the Davis principles underlie all of them and that the methods merge into each other so that frequently an operator will find it very difficult to place any certain case under a definite class of procedure. I feel personally that the three-joint operation can be the basis for the treatment of most feet needing arthrodesis, and practically all of my later cases fall into this class. However, many of my operations are atypical and arthrodesis of the calcaneocuboid joint frequently seems useless. Proper shaping of the contact between the stump of the neck of the astragalus and the scaphoid can certainly remove, in the vast majority of cases, the necessity for the replacement of the head as done by Hoke. With the removal of a large wedge through the mid-tarsal region for cavus deformity the simple three-joint and the Dunn procedures become almost identical from the practical standpoint. The accompanying diagrammatic drawings show the skeletal part of the common operations described, and one is immediately struck by the similarity of the end results.

The type of incision used in these cases seems to be of no great importance and to be largely a matter of personal preference. The transverse incision of Kocher, the long curved incision running under the external malleolus, and the longitudinal incision to the outer side of the common toe extensor are apparently the most common approaches, although some surgeons always use two lateral incisions. There is some advantage

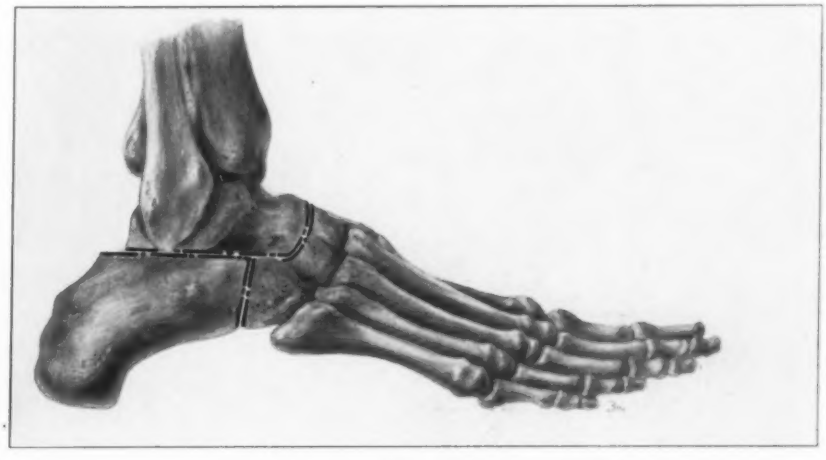

FIG. 8

Diagram of result after stabilization of a calcaneocavus foot by the Dunn type of arthrodesis. Compare with Fig. 7.

FIG. 9

Diagram showing character of bone incisions for correction of adduction deformity in the paralytic foot when the three-joint type of arthrodesis is used.

FIG. 10

Diagram of result after correction of adduction deformity in the three-joint type of arthrodesis. The original position of the bones is partially indicated by the dotted lines.

FIG. 11

Diagram after correction of adduction deformity in the Hoke type of arthrodesis. Note remodeled head of astragalus in position.

in an external incision in a varus foot and an internal incision in a valgus deformity, but very few operators put any stress on this point. Personally I prefer routinely the longitudinal approach for most cases, with a second incision on the inner side of the foot when necessary.

I have reviewed as thoroughly as possible in the time at my command two hundred and twenty-four subastragalar arthrodeses done by myself and my associates over a period of eight and a half years ending six months ago, and the results of the investigation, although preliminary in character, have made me very optimistic over the procedure. A number of cases where no postoperative data were obtainable are not included in the list. The failures and poorer results in the series are so easily explainable and their causes so evidently preventable that I feel one should obtain firm bony stabilization and proper alignment and balance in almost every case. Bony union apparently always occurs if the denuded surfaces are placed in a non-resisting apposition and the foot held in plaster long enough to allow proper healing. The failures have been due to: (1) improper or insufficient operation including failure to obtain correct posterior dislocation; (2) failure to balance the remaining muscle power; and (3) failure to remove sufficient wedges to completely overcome the existing deformity or deformities. Most cases have remained in plaster for six to seven weeks and the majority of them have had no support after that time. Some, of course, have been fitted with braces either on account of paralysis at the knee or to tempo-

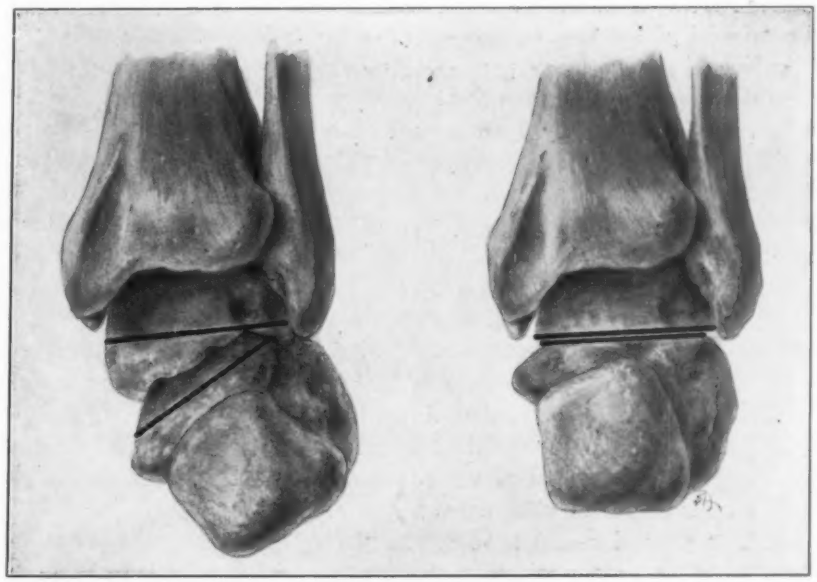

FIG. 12

Posterior view of a paralytic valgus foot showing bone incisions necessary for correction of the deformity and the result after correction by removal of the wedge outlined. Note how the os calcis is brought into proper alignment with the astragalus and the leg above it by this procedure.

rarily support tendon transplantations or bone blocks. It would seem as if prolonged fixation in plaster was unnecessary and that six to seven weeks could be accepted as sufficient time.

Although many of the operations were atypical, the cases fall into the three groups which have been discussed. In the first group are the cases in which a Hoke type of procedure was followed. In the second group are those in which only the astragalocalcanean and astragaloscaphoid joints were attacked, the two-joint type, and in the third group are the feet where a more or less typical three-joint or multiple joint operation was performed. Of the two hundred and twenty-four cases investigated, thirty-four belonged to the Hoke group, eighty to the simple two-joint type, and one hundred and ten to the three-joint variety. Eleven feet have been reoperated upon to obtain better position but only two of these had fibrous union, the others all showing bony fusion. The end results from the data obtainable show that two hundred and four, or ninety-one per cent. of the two hundred and twenty-four feet can be classified as "good to excellent" and the remaining twenty as "bad to fair". The classification of end results is always difficult and personal opinion enters so largely into it that definite lines can not always be drawn, but I believe that if the weight-bearing lines are good, the stabilization firm, bony union present, and the function such that appliances are unnecessary so far as the foot is concerned, we can safely classify such a case as "good to excellent" and this is the basis I have used. The cases in the "bad to fair" list are those which show a rather marked residual deformity although bony union is apparently present in all of the true subastragalar joints but absent in some of the astragaloscaphoid joints, due to faulty operative technique. These cases have not been reoperated upon for several reasons, the chief one being that the function is sufficiently good to allow the child to get around without trouble even if a considerable degree of deformity is present. The more recent cases in the series, done with the advantage of greater experience, seem to fall almost without exception into the "good to excellent" class.

In closing this discussion the following points should be emphasized:

1. Subastragalar arthrodesis, either alone or combined with tendon transplantation or bone block, is indicated in a greater number of cases than any other one operation in the treatment of paralytic feet.
2. The form of operation need not be stereotyped if the underlying principles of bony stabilization as first emphasized by Davis are kept in mind. All of the commonly performed arthrodeses give excellent results when correctly carried out.
3. The desired result should be obtained in practically every case with the proper selection of operation and careful technique. In the two hundred and twenty-four cases studied ninety-one per cent. showed satisfactory results and the failures were largely due to explainable and preventable causes. An experienced operator will probably have an almost perfect score.

RECONSTRUCTIVE SURGERY IN PARALYTIC DEFORMITIES OF THE LEG*

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In dealing with a case of deformity following infantile paralysis, we start with a knowledge of certain facts:

1. That power is deficient in one or more muscles or groups of muscles.
2. That deformity is usually associated with contracture of the stronger muscle groups.
3. That the deformity is usually aggravated by persistent posture and the incidence of body weight.
4. That the potentialities of recovery in the muscles which are overstretched can frequently only be assessed after these have had appropriate treatment in a position of relaxation over a prolonged period.

We are thus presented with the problem of how to make a limb already deformed and deficient in muscular control most useful to the patient. The generally accepted alternative lines of treatment are:

1. Gradual correction of deformity.
2. Forcible correction of deformity after division of tight structures.
3. Operations on bone.

Tendon transplantation or tenodesis are also recognized as allies after deformity has been corrected.

Let us consider the treatment of a patient in whom the upright position is not possible because of fixed flexion contracture of the hips and knees with associated deformity of the feet.

Surgically it may be possible to quickly correct these deformities, but we also know that divided tendons and muscles quickly undergo further shortening and atrophy, and the method we adopt should be based on this knowledge. I would submit as a principle that division or elongation of a tendon or muscle to correct deformity in infantile paralysis should not be practised unless we are satisfied:

1. That correction of deformity will improve function.
2. That division or elongation of the tendons is necessary to correct deformity.
3. That the power of the shortened muscle or tendon could not be utilized by tendon transplantation at the time of operation.

*Abstract of address delivered before joint session of the British and American Orthopaedic Associations, London, July 5, 1929.

I emphasize the importance of this because, if you refer to the textbooks, you will find only casual mention of the possibilities of gradual correction of flexion contracture of the hips, while the operations of Soutter[1] and Campbell[2] are given prominence and illustrated. By these operations we do at least two things, — we divide and so weaken the tensor fasciae femoris muscle, and we detach a large portion of the origin of the gluteus medius. The textbooks which give prominence to these operations also tell us that no splintage can mask the limp resulting from paralysis of the gluteus medius muscle, while Legg's operation of transplantation of the tensor fasciae femoris muscle is the only one recommended to replace its function. I agree that these operations may reduce the time necessary for correction of flexion contracture of the hip joint, but I would submit that the contracture resulting from infantile paralysis is the one in which they should seldom be employed.

We must realize that the methods of correcting these deformities were successfully practised before these operations were surgically safe, and we can only assess the value of them if we have experience of the possibilities of correction of deformity by gradual means.

(1) GRADUAL CORRECTION OF DEFORMITY

It is my good fortune to have been trained in a school in which success in the application of the principles of gradual correction of deformity has been very striking. I have learned that nature resents tension, and gradually allows relaxation of structures to which it is constantly applied. My experience is that operation is seldom necessary to correct flexion contracture of the hip in infantile paralysis. Tenotomy of the fascia I sometimes make a preliminary to gradual correction of deformity; but only in very severe old-standing cases would I consider a major operation.

During the last eighteen years I can recollect only once having anaesthetized a patient for correction of flexion contracture of the hip

FIG. 1

Dame Agnes Hunt's method of gradual correction of flexion contracture of the hip in infantile paralysis.

joints resulting from infantile paralysis, and in this case the iliofemoral ligament was found to be the main obstruction to correction.

Deformity of the Hip

To obviate the difficulty of increasing spinal lordosis in our efforts to overcome contracture of the hips by gradual splintage, I would recommend the method taught to me by Dame Agnes Hunt at the old Baschurch Home which will be known to many of you.

The principles of this method are:

1. The correction of lordosis by flexion of both hips while the spine and one flexed hip are immobilized in plaster-of-Paris.
2. The free limb is then fixed in a Thomas knee splint which is gradually lowered as the tight structures yield to extension and gravity.
3. The limb in which deformity has been corrected is then incorporated in plaster with the spine, while the other limb is gradually extended.

Deformity of the Knee

Here again good leverage is available, and any muscle shortening is usually gradually overcome by simple splintage.

Deformity of the Foot.

In the case of deformities of the foot I believe that division of tendons or muscles should still be resisted. The only tendon I sometimes elongate is the tendo Achillis, but even this simple operation is not to be undertaken lightly. A slight degree of shortening of the tendo Achillis may have advantages in infantile paralysis, — *e.g.*, in cases of quadriceps insufficiency, when weight is borne on the limb, the strain on the gastrocnemius muscle locks the knee joint and so increases its stability. In cases of simple cavus deformity the shortened tendon acts as an anchor which allows true correction of deformity by wrenching. In extreme equinus, elongation of the tendo Achillis may be necessary to allow relaxation and recovery of the weakened anterior tibial group of muscles. It should be elongated just enough to allow the right-angled position of the foot. In many cases of deformity of the foot, fusion of the tarsus in a good weight-bearing position will be desirable to insure stability of the foot. In these cases the tendo Achillis should always be elongated,

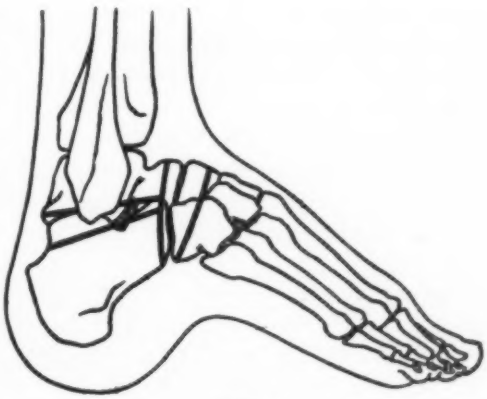

FIG. 2

Diagram to illustrate essential principles in tarsal arthrodesis[8].

if necessary, just enough to allow the normal weight-bearing relationship of the leg bones with the astragalus and os calcis.

(2) FORCIBLE CORRECTION OF DEFORMITY

This method I utilize mainly in correction of simple cavus deformity of the foot in children and young adolescents. After division of tight structures near their attachment to the os calcis, the Thomas wrench is used to supply the necessary leverage for correction of the deformity.

(3) OPERATIONS ON BONE

Arthrodesis of the hip or knee may in certain cases be desirable to increase stability or reduce splintage. These operations should seldom be employed in children, but they are alternatives, the advantages and disadvantages of which can be explained to the adult, so that he can form his own opinion.

In deformities of the foot following infantile paralysis, we find that these are mainly due to laxity or fixed deformity of the mid-tarsal and subastragaloid joints. I believe that arthrodesis of one or both of these joints is an essential basis for the best final functional result in all but the milder cases of paralytic deformity of the foot.

When I first published results of this operation for the treatment of calcaneocavus deformity of the foot at a meeting of the British Orthopaedic Association in May 1919[3], I stated that astragalectomy as advised by Whitman[4] "should be reserved as an alternative operation for cases in which paralysis of all the posterior tibial muscles as well as the tendo Achillis is complete". Further experience has satisfied me that this operation of astragalectomy should not now be taught or practised for the treatment of any type of paralytic deformity of the foot. It fails in that it does not correct mid-tarsal deformity, while it sacrifices movements in the ankle joint which can usually be controlled by tendon transplantation, or limited by tenodesis, when correction of tarsal deformity has been established by arthrodesis.

The operation of mid-tarsal and, or, subastragaloid arthrodesis I have now employed almost constantly for the treatment of paralytic deformities of the foot for thirteen years. The operation as I now practise it has already been published in detail[5]. The exposure of the tarsus allows:

1. Arthrodesis of both mid-tarsal and subastragaloid joints with or without backward displacement of the foot at the subastragaloid joint.
2. Actual shortening of the foot with or without backward displacement.
3. Arthrodesis of the mid-tarsal joints alone.
4. Arthrodesis of the subastragaloid joint alone.

5. Division of ligaments limiting movement of these joints to allow correction of deformity without arthrodesis.

My present position with regard to the operation is:

1. That it should not be performed in children under eight years of age if reasonable function without increasing deformity can be obtained by simpler means; but I have no hesitation in performing it on children of any age if there is a tendency to relapse in spite of less radical procedures, — such as manipulative correction of deformity, tendon transplantation, and splintage.
2. That much care must be taken to insure that the position of arthrodesis of the tarsus should be such as to allow weight-bearing on the posterior aspect of the os calcis, and on both the first and fifth metatarsal heads. Body weight should be transmitted through the center of the knee, ankle, and foot to these normal points of weight-bearing, and only to these.

Fusion of the Tarsus in a Faulty Position

Recurrence of deformity seems to me to have been due to failure to insure or maintain the correct weight-bearing position, or to the pull of unbalanced muscles or growing bone, — *e.g.*, a strong tibialis anticus muscle, where its opponents are paralyzed, will surely produce in a growing child a gradual recurrence of varus deformity. Restoration of muscle balance is essential for the best final functional result. Review of a large number of end results has shown that particular attention must be given to certain points in the treatment of each type of deformity of the foot.

Simple Varus Deformity

The removal of bone and division of ligaments should be such as to allow *easy* correction of adduction at the mid-tarsus and varus of the heel. If force is necessary for true correction of the deformity at the time of operation, we will find that this has been partially transmitted to the ankle joint, so that incomplete true correction of the varus is apparent as soon as the plaster is removed.

Simple Valgus Deformity

A good cosmetic result in the correction of this deformity has presented most difficulty. The method I advise is division of ligaments and free dislocation inwards of the foot at the mid-tarsal and subastragaloid joints before removing bone. Unless special care is taken, there is a tendency to fail to center the os calcis under the astragalus, or to truly correct the eversion and abduction of the fore part of the foot. The arches of the foot should be restored, but special care is necessary to insure that the position of arthrodesis allows of weight-bearing on the first as well as the fifth metatarsal head.

Simple Cavus Deformity

The majority of cases in which resection of bone has been limited to the mid-tarsus have been cases of simple cavus deformity. This is not

advised in young children, but in children over ten it has seemed to offer the best final result in some cases in which control of dorsiflexion of the foot was deficient. It limits foot-drop, and renders transplantation of muscles more effective. Mid-tarsal resection by itself is not advised unless the relations, stability, and control of the astragalus and os calcis are normal.

Equinus Deformity

Equinus deformity, whether simple or associated with varus or valgus deformity of the foot, requires special consideration. Before resection of bone we must be assured of the normal weight-bearing positions of the tibia, astragalus, and os calcis. Correction of equinus deformity by resection of bone at the mid-tarsus will result in prominence of the calcaneocuboid joint. This portion of the foot resents weight-bearing. It is, therefore, of the greatest importance that equinus deformity should be corrected by elongation of the tendo Achillis if necessary. If it is desired to maintain a position of slight equinus, the foot must be fixed in this position, while the normal longitudinal arch of the foot is maintained.

Calcaneocavus Deformity

The complete operation together with tendon transplantation and, or, tenodesis usually gives a good functional result, but in some cases an inversion of the fore part of the foot has resulted, so that weight-bearing on the first metatarsal head was not possible. In these cases a fixed flexion of the first metatarsophalangeal joint has been developed to support the inner side of the fore part of the foot on weight-bearing. This tilting up of the inner segment of the fore part of the foot would appear to be due to two factors:

1. That in this deformity the tibialis anticus is often active and shortened, and
2. That in order to relax transplanted muscles, the position of fixation is usually that of equinus.

In this position the inner border of the foot is drawn up by the shortened tibialis anticus, so that one of the normal weight-bearing points, the first metatarsal head, is lost.

Special care must be taken in postoperative fixation of the foot by limiting the degree of equinus if necessary, that weight-bearing on both the first and fifth metatarsal heads is assured.

Tendon Transplantation

As the result of the publications of Vulpius, Lange, and Codivilla, tendon transplantation for the restoration of function in infantile paralysis became more generally known and practised. During the first decade of the present century surgical asepsis made the operations safe, and they became a subject of intense surgical experiment. Prior to the War certain principles for success in the operations were established:

1. That previous to operation, correction of deformity should be complete.
2. That the transplanted muscle should run in a direct line from its origin to its new insertion.
3. That the muscle should be of sufficient power to meet the strain which would be imposed on it.
4. A recognition of the fact that where *3* was not practicable, transference of muscle power might be advantageously utilized as an adjuvant to other procedures such as tenodesis or arthrodesis.

Failures were, however, still common, and these were ascribed mainly to adhesions and faulty union at the point of insertion. The operation became generally less popular and more limited in application, while the explanation of failures became the subject of investigation in many research laboratories and surgical units.

Biesalski[6], Mayer[7], Steindler[8], and Bernstein[9] are among the main contributors to the modern literature which deals largely with the problem of the prevention of adhesions and the maintenance of nutrition of transplanted tendons. Although I appreciate their work, I do not agree with them that faulty nutrition of tendons, or adhesions, were the main cause of failure in a large number of tendon transplantations advised and practised. My experience has been that with transplantation of tendons through the subcutaneous tissues, you can be sure of success in some operations, and as certain of failure in others. On looking back on a fairly considerable experience of tendon transplantation, I am satisfied that success or failure has depended mainly on two other factors:

1. Whether the transposed tendon would naturally act or could easily be reeducated to perform its new function.
2. The degree of tension under which the new tendon was sutured.

I believe that given good surgical technique, the main axiom in tendon transplantation in the lower extremity should be that a tendon or part of a tendon should only be used to replace one of its own group, — *i.e.*, one normally in action with it. In the upper extremity the action of muscles is more specialized, so that reeducation of an individual tendon to act apart from its group appears to be more practicable.

The movements employed in locomotion are, however, automatic, and controlled by groups of muscles, so that it is more difficult to reeducate an individual muscle to act apart from its own group.

These views are confirmed by my personal experience of certain operations which are advised in the textbooks. I would refer particularly to transplantation of the biceps muscle to the patella in cases of quadriceps insufficiency, and transplantation of the peroneus longus muscle to replace a paralyzed tibialis anticus. In both cases the tonic action and the fact that we have weakened a group that was stronger than its opponents may justify the operation as a means of increasing stability, but the cases in

which the one functions as an active extensor of the knee, or the other as an active dorsiflexor of the foot, must be very rare.

For quadriceps insufficiency the only operation I practise is transplantation of the sartorius or the tensor fasciae femoris to the patella[10]. Both are naturally in action in extension of the knee joint, and the transference of their insertion to the patella only makes their power more effective.

The case I demonstrate shows extreme hypertrophy of a tensor fasciae femoris muscle, and the tight cord passing from it to the patella on active extension of the knee clearly demonstrates that it is responsible for the action.

When we come to paralysis of the foot the evidence in favor of this axiom is very striking. There are here for practical purposes only two groups of muscles, — one group, the anterior tibial in action in dorsiflexion of the foot, the other, the peroneal and posterior tibial muscles associated in action with the tendo Achillis in plantar flexion. We find that any of the anterior tibial muscles may successfully replace one another, — *e.g.*,

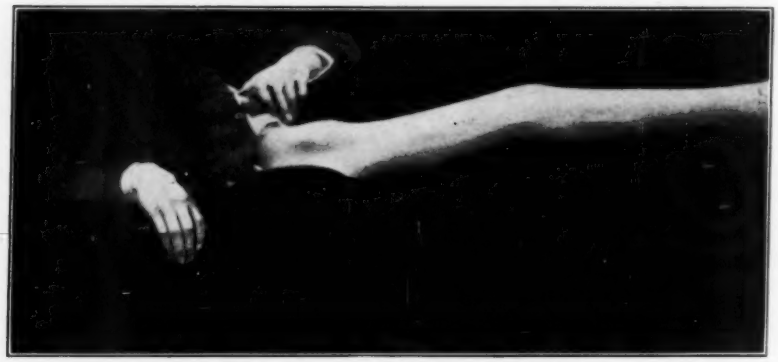

FIG. 3

FIG. 4

Showing hypertrophy of tensor fasciae femoris and its action as an extensor of the knee joint after its transplantation to the patella. (*Courtesy of the British Journal of Surgery.*)

the tibialis anticus may be transplanted to the outer side of the tarsus, or the active power in the extensor longus hallucis can be transposed to the tibialis anticus with certainty of success. On the other hand, no tendon transplanted from the peroneal or posterior tibial group will be effective in replacing the loss of active dorsiflexion.

In practice the posterior tibial and peroneal muscles are associated with the tendo Achillis in extension of the ankle, so that they can be used to replace one another with certainty of success. The successful use of active posterior tibial and peroneal muscles to replace a paralyzed tendo Achillis is a striking illustration of the group action of muscles in the lower extremity. The degree of tension under which tendons should be sutured, and whether their insertion should be tendons, periosteum, or bone, are still matters of argument. Personally I suture tendons under considerable tension, and do not consider it essential even in the foot that the insertion should be into periosteum or bone.

Tenodesis

The operation of utilizing tendons as ligaments to limit joint movement has a definite value in the improvement of function in infantile paralysis. In the lower limb I frequently use a portion of the tendo Achillis to maintain the position of slight equinus in cases of calcaneocavus in which sufficient power is not present in the peroneal and posterior tibial groups to replace the function of the tendo Achillis.

LESSONS LEARNED

Although I have not personal experience of all the methods advised in the textbooks and the literature on reconstructive surgery in paralytic deformities of the leg, I believe: —

1. That muscle power being already deficient, every effort should be made to correct deformity by gradual methods. Division of tight structures usually means division of active muscles. Division weakens a muscle, so that it is less valuable for control of the limb or for transplantation, — *e.g.*, transplantations of the tensor fasciae femoris at the hip or knee must be less effective if the muscle has been allowed to retract as a result of division of its origin.
2. That in the lower extremity transplantation of muscles or tendons should be confined to the group with which they are normally in action.
3. That in all but the milder cases of paralysis of the foot an arthrodesis of the tarsal joints is an essential preliminary to tendon transplantation and, or, tenodesis, to insure the best final functional result.

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A TEACHING MODEL FOR THE DEMONSTRATION OF THE OPERATIVE CORRECTION OF SEVERE PARALYTIC VALGUS*

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Dr. Henderson's paper on the operative correction of paralytic foot deformities has emphasized an opinion which among a growing number of orthopaedic surgeons is becoming a firm conviction: namely, that when deformity is due to muscle imbalance, a permanent result can be best secured by combining bony correction with a tendon transfer designed to restore muscle balance. Although either bone operation or tendon transfer alone will frequently suffice to cure milder deformities, it is only by the double procedure that the severe grades can be satisfactorily treated.

FIG. 1

The outer aspect of the pasteboard model illustrating the first incision beginning at the external malleolus and extending downward to the cuboid, and the fourth incision extending from the malleolus upward towards the knee.

FIG. 2

Outer aspect of the pasteboard model with the flap retracted to show the exposure of the dorsal joints and the peroneus longus tendon below the ankle.

*Abstract of address delivered before joint session of the British and American Orthopaedic Associations, London, July 5, 1929.

When dealing for instance with an outspoken paralytic valgus, characterized by a marked displacement of the head of the astragalus and the scaphoid downward and inward, with a complete paralysis of the tibialis posticus and anticus, and with overactive peroneals, the operation of choice consists of,—first, complete correction of the bony deformity, best accomplished, I believe, by Hoke's method; second, by a transfer of the peroneus longus to replace the paralyzed tibialis anticus, preferably by the intrasheath method devised by Biesalski and myself.

For teaching purposes I have constructed a cardboard model, two and a half times the size of an average adult's leg. The model consists of two sheets of cardboard, fastened together along one edge by hinges of adhesive plaster. On one sheet is pictured the outer aspect of the foot and calf (Fig. 1), on the other the inner aspect (Fig. 4). The model is built in a series of layers, each disclosed by reflecting an appropriate flap, thus permitting a demonstration of the steps of the operation. Although the model is intended only as a diagram, I find that it gives a large group of students a far clearer conception of the operation than they can gain by witnessing the operation from the seats of an amphitheater. It is obvious that the actual execution can be learned only by practice on the cadaver.

FIG. 3

Outer aspect of the pasteboard model after removal of the head of the astragalus. The head can then be reshaped and replaced in a position which will overcome the previous deformity.

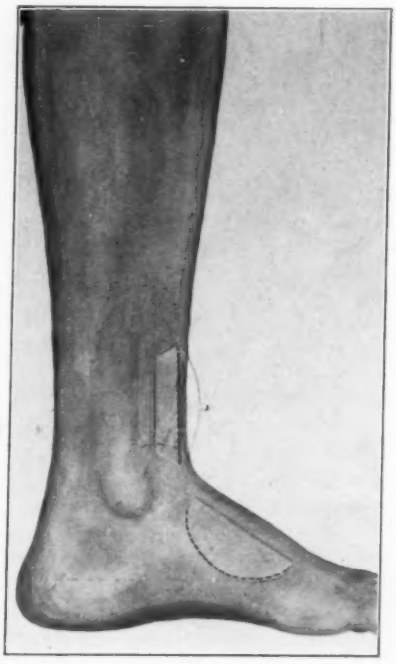

FIG. 4

Inner aspect of the pasteboard model showing the crescentic incision for the exposure of the insertion of the tibialis anticus tendon and the incision over the upper pole of the tibialis anticus sheath.

The steps of the operation are as follows:—Figure 1 shows the first skin incision beginning just back of the external malleolus and extending forward to the anterior margin of the cuboid. In Figure 2, the extensor brevis digitorum has been dissected away from the os calcis, exposing the calcaneocuboid joint; the dorsiflexors together with the dorsalis pedis artery have been lifted away from the neck of the astragalus, exposing the astragaloscaphoid joint. The astragalocalcaneal joint has been opened by incising the external lateral ligament of the angle. The sheath of the peroneus longus tendon has been slit to permit the removal of the tendon during the second half of the operation. In Figure 3 the astragalus has been beheaded by cutting through the neck with a sharp chisel. The cartilage can now be removed from the articular surfaces of the scaphoid, astragalus, and os calcis, and the calcaneocuboid joint. The head of the astragalus, denuded of cartilage and properly reshaped, is reimplanted, not in its original situation, but more toward the outer border of the foot. The division of the ligaments must be sufficient to permit complete correction of the original deformity. The deep parts are then drawn together by interrupted chromic gut stitches. The skin is temporarily closed by a towel clip. At this stage of the operation, the surgeon should be able to

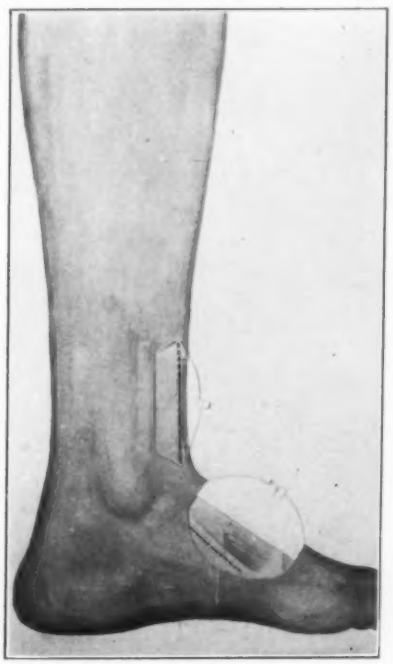

FIG. 5

Inner aspect of pasteboard model after the flap has been raised, showing the tibialis anticus tendon near its insertion. The dotted line indicates the way in which the tendon is split into longitudinal halves.

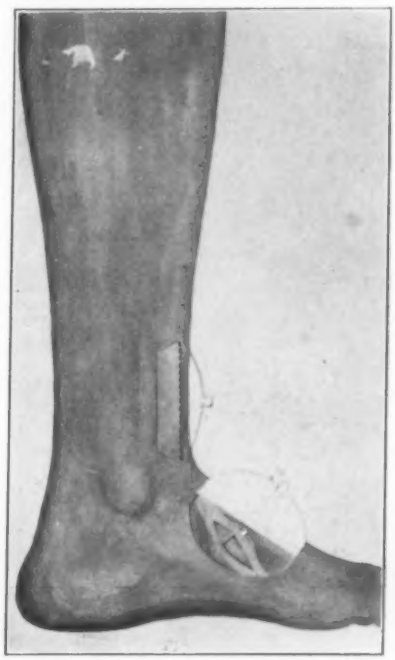

FIG. 6

Inner aspect of the pasteboard model, showing the tibialis anticus split into longitudinal halves and the joint between the first metatarsal and internal cuneiform.

maintain normal alignment of the bones, both in dorsiflexion and plantar flexion of the foot.

He is now ready for the second half of the operation:—the transfer of the peroneus longus to replace the tibialis anticus. The long peroneal is the muscle of choice; first, because its muscle fibers arise from the proximal half of the fibula and its tendon can therefore be completely freed, without sacrificing any muscle fibers; second, when the tendon is thus freed it can be made to run in a straight line downward and inward to the sheath of the tibialis anticus whose action it can almost exactly imitate. This is not true of any other tendon of the foot except that of the extensor proprius hallucis. The peroneal longus is, however, far more powerful than the extensor hallucis and its everting action far greater. Therefore, the effect of its transfer is a much more radical redistribution of the muscle forces.

The first step of the tendon transfer consists of the exposure of the tibialis anticus tendon at the insertion and the preparation of the implantation site for the peroneal tendon. Figure 4 shows the crescentic skin incision whose center corresponds to the joint between the first metatarsal

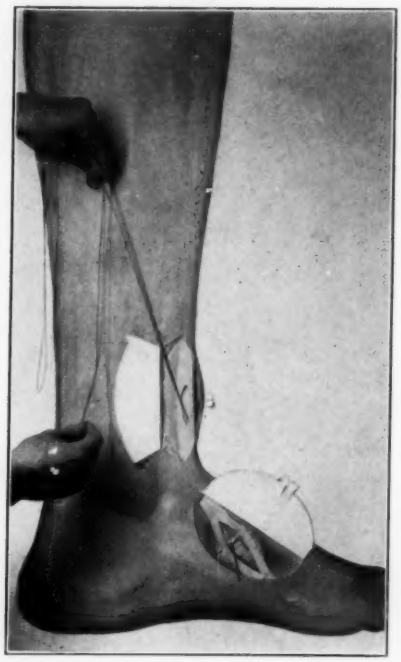

FIG. 7

Inner aspect of the pasteboard model. The flap has been retracted, exposing the upper pole of the tibialis anticus sheath. A flexible eye probe has been passed into the upper pole of the tibialis anticus sheath and made to travel downward through the sheath emerging near the insertion of the tibialis anticus tendon.

FIG. 8

Inner aspect of the pasteboard model. The probe has been drawn through, carrying with it a loop of strong silk. The two free ends are seen emerging below, the loop emerges from the upper pole of the sheath of the tibialis anticus.

and the internal cuneiform. In Figure 5 is seen the tibialis anticus tendon passing to its insertion. A dotted line indicates the manner in which the tendon is slit longitudinally into halves. In Figure 6 the two halves are retracted, exposing the metatarsocuneiform joint. This is denuded of cartilage and a bone flap about one-quarter inch wide by one-half inch long is turned up from the superficial cortex. This serves later for the attachment of the peroneal tendon.

The path of the peroneal tendon through the tibialis sheath must now be prepared. Figure 6 shows the skin incision over the proximal pole of the anterior tibial sheath. An incision about one-eighth inch long is made in the sheath and into this opening a flexible eye-probe is passed (Fig. 7). The tip should be bent to form a gentle convexity and with the tip directed toward the skin, it is easy to shove the probe downward through the sheath, beneath the annular ligament, and with a slight shove it is made to pierce the lower pole of the sheath. It then emerges near the longitudinal slit in the anticus tendon. Into the eye of the probe a loop of silk is threaded.

FIG. 9

Lateral aspect of the pasteboard model. The flap has been retracted, exposing the peroneus longus tendon and the distal muscle fibers. It is seen covered by the fascia lata.

FIG. 10

Outer aspect of the pasteboard model. Two fascial flaps have been formed, one over the peroneus muscular compartment, the other over the anterior muscular compartment. These fascial flaps have been everted, exposing their deep surface which is coated with gliding tissue and they are being united by a fine silk stitch so inserted as to approximate their smooth gliding surfaces and thus form a bridge over which the peroneal tendon can glide.

This is drawn downward through the sheath in such a way as to leave the loop proximal (Fig. 8) and the two free ends distal.

The foot is next turned to expose the outer aspect of the calf. The model is given a corresponding turn. This incision (Fig. 1) begins at the external malleolus and runs upward and inward to a point two-thirds the distance from the ankle to the knee and midway between tibia and fibula. In Figure 9 the skin has been retracted, showing the white fibers of the peroneus longus tendon into which the muscle fibers are seen inserting. Both are covered with a well developed layer of fascia lata. In the model this is illustrated by a strip of white crinoline. Anterior to the peroneus muscles lie the dorsiflexors. They are separated from the peroneal group by a dense fascial septum known as the septum intermusculare anterius. In order to prevent adhesions in the course of the peroneal tendon from its own fascial compartment into that of the tibialis anticus, I have had recourse to a fascial plastic. This is illustrated in Figure 10. Two longitudinal slits are made in the fascia, one over the peroneal compartment, one over the anterior muscular compartment. These slits are

FIG. 11

Inner aspect of the pasteboard model. The eye probe has been inserted into the upper pole of the tibialis anticus sheath and is being passed in an upward and outward direction towards the peroneal compartment. It carries with it the loop of the guide suture which is made to emerge in the region of the fascial plastic.

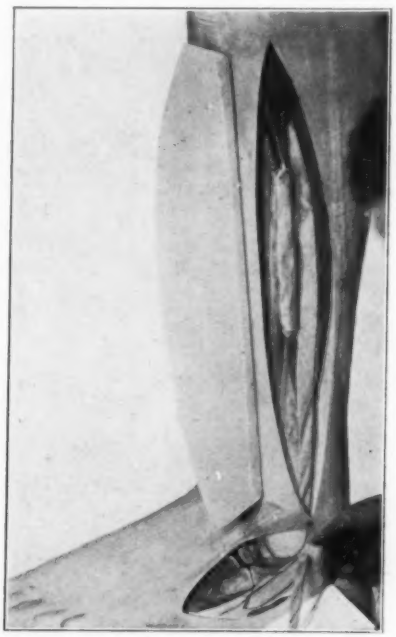

FIG. 12

Lateral aspect of the pasteboard model. The peroneus longus tendon has been divided just before it passes through the groove in the cuboid bone. The operator is now ready to free it as far upward as the fascial plastic.

approximately three inches long. At each end of the slit a small transverse incision is made, thus outlining two flaps of fascia. As these flaps are everted it is seen that their deep surface is coated with the gliding tissue (paratenon) which makes possible the free gliding motion of the tendon beneath the rigid fascia. The two flaps are brought together by means of a very fine silk stitch inserted exactly as the serosa suture of a gastro-enterostomy. In this way the silk is completely buried, leaving a fascial bridge coated with gliding tissue over which the peroneus longus tendon can glide from its own compartment into the anterior without the danger of adhesions developing.

It is now necessary to bring the guide suture from the upper pole of the tibialis anticus sheath upward and outward beneath the fascia to the region of the fascial plastic. The way in which this is done is shown in Figure 11. This shows the inner aspect of the foot with the tip of the probe entering the tibialis anticus sheath pointed in an upward direction. The tip of the probe punctures the upper pole of the sheath, then passes beneath the fascia without encountering the least opposition, since it is traveling through

FIG. 13

Lateral aspect of the pasteboard model. The peroneus longus tendon is passing over the fascial bridge. The upper portion of the tendon is supported by a blunt instrument to prevent it from twisting or buckling as the tendon is pulled downward through the tibialis anticus sheath.

FIG. 14

Inner aspect of the pasteboard model. The peroneal tendon has been drawn downward to the insertion of the tibialis anticus and is about to be fastened to the first metatarsal bone by means of a strong chromic gut stitch.

gliding tissue and emerges near the fascial plastic. The loop of the guide suture is threaded into the eye and this is pulled out with the probe. The operator has in this way placed a guide suture which runs from the fascial plastic downward through gliding tissue to the upper pole of the tibialis anticus sheath and downward through the sheath to the insertion of the tibialis anticus tendon. The peroneal tendon is now exposed down to the point where it grooves the cuboid bone. Here it is divided transversely, the proximal stump is grasped with a tendon clamp and a strong No. 3 chromic stitch is inserted. The tendon is lifted up from the surrounding structures from which it is freed by a few cuts of the scissors. The ends of the chromic gut stitch are caught in the loop of the guide suture and easily drawn downward through the pathway already prepared. In Figure 13 the tendon is seen passing over the fascial bridge on its way to the tibialis anticus sheath. The lower fibers of the muscle are supported by a blunt clamp so as to prevent them from twisting or buckling. In Figure 14 the peroneal tendon is shown emerging between the split halves of the tibialis anticus tendon at its insertion. The peroneal tendon is fastened to the raw bone beneath the bone flap and is held there by means of the chromic gut stitch inserted to facilitate its passage through the sheath. The operation is completed by closure of the incisions and the application of a plaster-of-Paris dressing which holds the foot in a corrected position.

BONE-BLOCK OPERATION FOR DROP-FOOT; ANALYSIS OF END RESULTS*

BY W. C. CAMPBELL, M.D., MEMPHIS, TENNESSEE

A preliminary report of an operative procedure for the correction of gravity flexion of the foot, or drop-foot, was made before the American Orthopaedic Association in 1923. Subsequent reports were made before the Orthopaedic Section of the American Medical Association in 1925, and before the New York Academy of Medicine in 1927.

A committee, appointed by the American Orthopaedic Association to investigate the value of the various operations routinely employed in the treatment of paralytic feet, made a comprehensive report to the Association in 1921. This committee, after observation of the end results in many large clinics in America, very clearly stated, regarding drop-foot, that none of the operative measures employed at that time could be confidently recommended as a standard procedure.

At the time of this report and prior thereto, the mechanical principle of all operative measures for correcting drop-foot was to suspend the foot from the tibia by artificial or transplanted ligaments. Silk, fascia lata, and the flexor tendons were employed for this purpose. For a short time the desired position was maintained, but in a large proportion the constant force of gravity induced an elongation of the new ligaments with a recurrence of the original deformity. Undoubtedly, excellent results have been obtained by a comparatively small number of surgeons, notably Gallie, of Toronto, and Putti, of Bologna, by employing the extensor tendons; but this has not been the experience of the majority of surgeons. The fact that paralyzed tendons will not withstand continued stress is so universally recognized that it has become an axiom. Astragalectomy, as described by Whitman, will, of course, stabilize the foot in all four directions, and is an excellent procedure, but is not applicable to all paralyzed feet. Triple arthrodesis, as described by Davis, Dunn, Hoke, and Ryerson, may, in a small proportion, accomplish the same result, if an extensive dissection about both malleoli is performed and the foot displaced backward. Toupet, in Paris, employed a graft from the tibia which was driven through the os calcis for the purpose of blocking the ankle joint posteriorly and preventing gravity flexion. Lambrinudi, in England, has described a procedure upon the forefoot, and Nové-Josserand, of France, has recently described a procedure somewhat similar to that of the author.

The principle of the bone block for stabilizing paralytic joints was first employed by the author in 1917, by arthrodesing the patella and the tibia in a patient with genu curvatum.

*Read at the Joint Meeting of the American and British Orthopaedic Associations, London, July 6, 1929.

The operation under consideration was first devised in 1922, since which time over seven years have elapsed and the technique described below has been employed in over 300 cases. Therefore, sufficient time has elapsed to determine the actual value of the procedure as manifested by the end results. The object of the method is to construct an osseous process posterior to the ankle joint, which is attached to the os calcis and which will impinge upon the articular surface and the posterior surface of the tibia, blocking ankle motion at about ten degrees of plantar flexion. In America, Henderson, Meyerding, Dickson, Diveley, Leo Mayer, and others have reported satisfactory results. Ollerenshaw reported a series of cases before the meeting of the British Orthopaedic Association, in October 1925; of twenty cases he demonstrated excellent results in eight. It is quite apparent that the procedure has been of value in all paralytic deformities of the foot with the exception of cavus, valgus, calcaneus, and calcaneovalgus.

INDICATIONS

The scope of the procedure does not seem to be fully appreciated, though discussed in the first report. Poliomyelitis is by far the most frequent etiological factor in drop-foot, but this condition may occur as a result of any factor by which the ability to dorsiflex the foot has been destroyed, as destruction of the muscles and tendons from trauma or burns, toxic neuritis, — as in lead poisoning, — severance of the external popliteal nerve and spastic paralysis. The operation is employed, not alone in simple drop-foot, but also when associated with other deformities of the foot. The indications are as follows:

1. Simple drop-foot, as a result of the loss of function, by paralysis or otherwise, of the anterior group of muscles of the leg. Usually the mid-tarsal joints are lax and require stabilization. This necessitates the excision of bone which may be utilized for transplantation.

2. Partial loss of function in the anterior group of muscles, as manifested by a decrease in normal function from twenty-five to fifty per cent. A block may so relieve muscle strain that practically normal function is restored.

3. Rigid equinus in which the anterior group of muscles is partially, if not completely, paralyzed. In this condition the block prevents recurrence and relieves strain on weakened structures.

4. Equinovarus with paralysis of the extensor muscles. The varus is corrected by tarsectomy when sufficient bone can be obtained for transference.

5. Equinovalgus when associated with decrease in function of the anterior group of muscles. Resection of bone from the forefoot is often indicated and the bone may be utilized for transplantation.

6. Flail-foot with complete loss of muscle power. As an addition to the Davis, Dunn, Ryerson, or Hoke arthrodesis, stabilization of antero-posterior motion may be insured by the drop-foot operation.

7. As an adjunct to the transference of various tendons.
8. Spastic spinal paralysis with overactivity of the extensor muscles.
9. In children over the age of eight years. Prior to this age stabilization operations are rarely indicated and often a more advanced age is preferable.

TECHNIQUE

The technique of the operation is as follows:

The skin incision is made over the tendo Achillis, if this structure is contracted; otherwise, to the inner and outer side, as convenient in the individual case. The incision extends upward from the tuberosity of the os calcis for three or four inches. If the tendo Achillis is contracted, severance is made by the routine plastic method. Anterior to the tendo Achillis a straight incision is made in the midline to the posterior portion of the ankle joint, the tendon of the flexor longus hallucis which traverses the posterior capsule of the ankle joint being carefully retracted to the mesial aspect. Occupying the space between the tendo Achillis and the

FIG. 1

Photograph showing paralytic drop-foot following infantile paralysis.

FIG. 2

Same as Fig. 1 after triple arthrodesis and drop-foot operation.

ankle joint, will be found a mass of fat and connective tissue. A pyramidal space is cleared with a heavy periosteal elevator, exposing the posterior surface of the tibia, the posterior capsule of the ankle joint, and the superior surface of the os calcis. The foot is then dorsiflexed and the posterior capsule is incised transversely, bringing into view the posterior extremity of the astragalus and the subastragalar joint. Approximately one-half an inch of the posterior extremity of the astragalus is excised with a curved chisel, so as to permit close approximation of the graft and to insure an intra-articular, as well as an extra-articular block. This particular step is most important, as failure in securing the desired result is usually due to placing the transplants too far back upon the os calcis. After removal of the posterior extremity of the astragalus, the articular cartilage is removed from the subastragalar joint, and a cavity is made in the os calcis below and in line with the posterior portion of the articular surface of the tibia. Cavernous or spongy bone is transplanted from any convenient portion of the skeleton; one large mass is placed in the cavity in the os calcis, after which small particles are packed in a pyramidal manner extending about one inch above and posterior to the lower extremity of the tibia. A new process of bone is thus made which will impinge upon the inferior and posterior aspect of the tibia. Care is taken that the superior extremity of this mass is made blunt or rounded so as to avoid a spicule which may later be fractured. As it is usually necessary to excise bone for the purpose of stabilizing most paralytic feet, this bone may be preserved and utilized to form the process above described. The cartilage is removed from the excised bone before transplanting, though if material is scant, the bone and cartilage may be cut into small particles by bone forceps. The flakes of

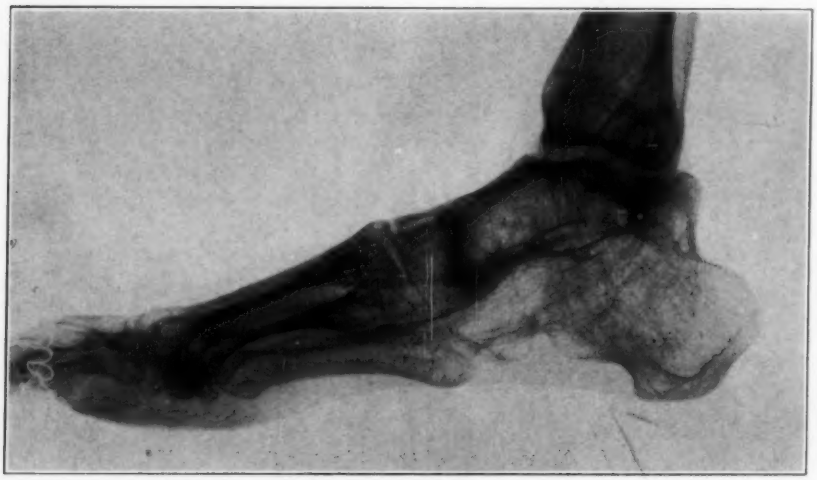

FIG. 3

Roentgenogram after triple arthrodesis and drop-foot operation. Note osseous fusion of the astragaloscaphoid, calcaneocuboid, and subastragular joints, and bone block posterior to astragalus.

cartilage may be placed in mosaic fashion to invest the inner, outer, and posterior aspects of the transplanted mass so as to prevent adhesions to surrounding tissue, though this is by no means essential, as results are just as satisfactory when bone free of cartilage is obtained elsewhere. The connective tissue anterior to the tendo Achillis is sutured snugly to retain the transplants in situ, the tendo Achillis is united, if severed, and the fascia and skin are closed in routine manner. The foot is then placed in a plaster cast at an angle of ninety degrees with the leg, as it has been found that about ten degrees of plantar flexion is secured later when this position is employed. Care must obviously be taken not to induce blocking above a right angle, as dorsiflexion may cause heel-walking. At the end of eight weeks the cast is removed and a roentgenogram is made which usually demonstrates proliferation of the transplanted bones. A sequence of roentgenograms exhibits a gradual organization of the bone until the osseous process is demonstrated continuous with and forming a part of the os calcis, and fusing the os calcis and the astragalus together, thus stabilizing the subastragalar joint. The after-treatment consists of a brace which prevents plantar flexion until there is complete organization of the transplanted bone into a strong osseous mass, which usually requires about six months. The technique may be modified, when the forefoot is stable, by turning the upper third of the os calcis forward, and fusing the subastragalar joint by the posterior route. It is also possible, when doing a triple arthrodesis, to transfer particles of bone from the mid-tarsal region, through the subastragalar joint to the superior surface of the os calcis without making the posterior incision, but the block cannot be so accurately placed as when the posterior incision is employed.

ANALYSIS OF END RESULTS

The operation has been employed in over 300 cases, and the end results personally observed by myself or my colleagues, Dr. J. S. Speed and Dr. Joseph I. Mitchell. No hearsay evidence, by letter or otherwise, has been accepted. Of the total number of cases in which this operation has been employed, end results have been carefully analyzed in 225. The relative value of the procedure in adults and children was fully discussed before the Orthopaedic Section of the New York Academy of Medicine. At that time the results in 162 cases were reported, of which seventy-six were children and eighty-six adults, or above fourteen years of age. Of the seventy-six children there were seventy-one in whom the feet were efficiently blocked; of the eighty-six adults, eighty-three were efficiently blocked. The results in children were, therefore, excellent in ninety-two and eight-tenths per cent. and in adults in ninety-six and five-tenths per cent. As there is so little difference, no distinction will be made in this discussion, the group of 225 being considered without reference to age.

Roentgenograms should be made at intervals after this procedure, as in all operations for stabilization of paralytic feet, until there is complete

organization or osseous fusion. This was not our practice at the time the operation was devised and, therefore, demonstration of the block can be made in only 143 of the 225 cases. The end results, as demonstrated by the roentgenogram, and the functional clinical results coincide in a large percentage, though not in all instances; as it has been observed that an apparently efficient block, as demonstrated by the roentgenogram, may not in reality prevent plantar flexion of the foot. Conversely it has been observed that an apparently deficient block has produced a most excellent mechanical result. Serial roentgenograms in 143 cases have been carefully reviewed and the process of organization of the transplant observed. In only one instance was there absorption or atrophy of the grafts and even in those which were mechanically defective from errors in technique, there was proliferation with organization into new bone, which is conclusive proof of the action of spongy or cavernous bone as a free autogenous transplant. In fact, the transplanted spongy bone survived and was productive in ninety-nine and five-tenths per cent., which is much higher than ever observed when dense bone was employed as a free graft for any purpose.

The bone block, to meet all requirements, should adhere to the following dicta: the osseous process should be compact and well organized, of sufficient dimensions, in close approximation to the posterior aspect of the ankle joint, and united by osseous fusion to the posterior extremity of the astragalus and the superior surface of the os calcis. The morphology and mechanism of the transplanted bone, as demonstrated by the roentgenogram, offers a most instructive study in osteogenesis, with variations in structure which may be enumerated as follows:

1. The common type is an osseous process fused to the os calcis and the astragalus, extending backward upon the posterior surface of the astragalus and upward at a right angle posteriorly to the tibia, so as to induce an intra-articular and extra-articular impingement.

2. The posterior extremity of the astragalus alone may be hypertrophied, producing only an intra-articular impingement.

3. An osseous process attached to the upper surface of the os calcis may extend upward, impinging upon the posterior surface of the tibia, entirely extra-articular. This type occurs when the posterior extremity of the astragalus is not removed and close approximation is not secured, and the possibility of permanent success is not so great as in the common type.

4. The posterior extremity of the astragalus may be enlarged, and project backward, conforming to the anatomical shape of the astragalus.

5. There may be grotesque and excessive proliferation. This type is probably due to either too extensive trauma during operation or to abnormal capacity for bone production on the part of the individual.

6. A longitudinal mass of bone well placed and preventing plantar flexion, but not united by bone to either the astragalus or to the os calcis. This also is obviously due to error in technique.

7. The osseous mass may be united to the tibia, the os calcis, and

the astragalus, thus inducing fusion of the ankle joint. This is probably caused by undue trauma to the posterior surface of the tibia. This result was observed in only two instances, and, while undesirable, has been the basis of evolving a procedure for extra-articular fusion of the ankle joint.

The common type is observed in a large percentage and has become almost the uniform end result, as the technique of the operation has been developed by experience. The other types are of rare occurrence, but are mentioned, as postoperative roentgenograms are frequently sent to the author for opinion as to the efficiency of the procedure. The clinical and practical end results depend, to some extent, upon the efficiency and success of the associated procedures for stabilization of the forefoot, but in estimating the results in this analysis, the efficiency of the block alone has been considered. The summary of the clinical end results in 225 cases and the manifestations of the roentgenogram in 143 cases is shown by the following tables:

CLINICAL RESULTS

Total number	Bone block efficient	Bone block deficient	Pain in heel	Late fracture of graft
225	211	14	4	1

ROENTGENOGRAPHIC DEMONSTRATION

Total Number	Well developed osseous process	Deficient osseous process	Late fracture of graft
143	133	10	1

Of the 225 cases, there were fourteen in which the osseous process did not permanently prevent drop-foot, making the percentage of successful results ninety-three and eight-tenths. Although plantar flexion recurred in fourteen cases, in only ten, as demonstrated by the roentgenogram, was the process apparently defective. Therefore, there were four in which the roentgenogram demonstrated a well developed osseous process which did not mechanically prevent extension. These failures occurred in those patients with undue relaxation of all ligaments and soft structures about the ankle. The objections which have been made to the drop-foot operation have not been borne out by experience. The probability of persistent pain from pressure of the new osseous process has been suggested, but postoperative pain was a definite symptom in only four adults, and in only one was a secondary operation necessary to excise a portion of the graft. No child has complained of pain in the heel as a remote or permanent symptom. There was a fracture of the tip of one process which caused pain and swelling for several days, but subsided without treatment. It has also been stated that the intra-articular process would probably induce osteo-arthritis by irritation, as is frequently observed following fractures involving joints. In not one of the 225 cases has subsequent arthritis been observed. There were two cases, not reported in this series,

in which the results were disastrous. One, in which a triple arthrodesis was performed, developed an intense postoperative infection. The foot was later amputated against the author's advice and judgment. In one negro child, tetanus developed at the end of one week which resulted fatally. This boy had been accustomed to going barefooted, was treated in bed, with frequent cleansing, for ten days prior to the operation. Since this catastrophe, antitetanus antitoxin is administered in immunizing doses prior to operation in all children who have been running about on their bare feet.

CONCLUSIONS

1. The operation is simple, as the bone for transplantation is usually available from associated operative procedures.

2. Apparatus may be discarded as a natural internal brace is constructed.

3. Muscle power is conserved by overcoming the constant force of gravity.

4. Prevention of overstretching may, of itself, permit a return of dormant muscle power.

5. Rocker motion of the ankle joint is conserved.

6. Stabilization is rendered more effective by the bone block and the incident additional fusion induced between the astragalus and the os calcis. The percentage of satisfactory and permanent end results in the stabilization of paralytic feet has been found to be thus materially increased.

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THE TREATMENT OF DISABILITIES RESULTING FROM LOW BACK DERANGEMENTS*

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The diagnosis of low back derangements is often difficult and it is equally difficult to apply the treatment best adapted to this special group of complex cases. Too much of routine has crept in — too much advocacy of special theories of etiology and of functional pathology,—too much stress on special methods of treatment, conservative or operative. This joint area is a complicated one and the explanation of the causation of many of the symptoms is not yet satisfactory,—as, for instance, the symptom of pain. A number of affections of this area may give similar signs and symptoms. Nor must we forget that important part which the general systemic condition plays in the prominence or the occurrence of the same symptoms or signs, which are met with in a purely mechanical derangement or even a pathological condition.

This subject of low back derangement has had an interesting development and a precocious growth. Although the lesions of the sacro-iliac joint were recognized by early observers, they had not been considered of special importance until about 1912. From this time an interest was awakened in many localities and an opposition in others, but this opposition helped rather than hindered the study of these conditions and with the gradual recognition of the frequency of lesions of this special area came the realization of their importance. In the early period it seemed that the affections of this part of the spine presented a simple problem,—that of strain of the sacro-iliac joint or sometimes a degree of subluxation—a definite anatomical lesion, with a clear clinical picture and with signs and symptoms indicating diagnosis and treatment. This diagnosis certainly explained many clinical conditions before not understood, removed from the group of tuberculous lesions many cases condemned to long restrictive treatment, and allowed them to return to active life. Little by little, as this group grew in size, the diagnosis became less rather than more sure, the problem of differentiation and of decision as to diagnosis and treatment correspondingly difficult. The part played by possible derangements other than of the sacro-iliac joint in this localized area was evident, for the lumbosacral and the sacro-iliac joints, so closely placed anatomically, bear together the stress that comes to this part of the spine. With the growing recognition of the importance played by the lumbosacral joint, the differential diagnosis of derangements of this joint and of the sacro-iliac joint became more difficult, particularly since there are no pathognomonic

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symptoms of the various types of derangements of this region, either as to character or location of the lesion.

Eliminating the cases with actual pathology and the cases of muscle or muscle-attachment strain, there exists a very large class of pure joint cases which, because of the unusual formation and relation of this group of joints, are to be regarded as having a special clinical entity and which, because of their intimate anatomy and function, must be considered together with reference to the influence that a derangement of one may have on the other. The large group of these non-pathological cases classed under the term "derangement" must be considered under the general head of joint strain—with or without a slight degree of displacement. Many of the pathological affections give much the same evidence as do the cases of pure derangements, but the recognition and treatment of these pathological conditions of this area are comparatively simple, for the x-ray corroborates the clinical evidence, and makes clear the nature of the affection, which then can be treated by the accepted and established methods. It is intended in this communication to consider the cases of derangement only, eliminating those cases which show definite pathological lesions.

CASES PRESENTING A NORMAL ANATOMICAL STRUCTURE

In dealing with cases of normal anatomical structure and relations, the therapeutic problem is that of ordinary strains such as would involve any joint, except that they involve a complicated joint group. The principle of treatment is the same as with other joints, applied with the recognition of the peculiarities of this complicated area, and should have the same consideration. In the past, while these derangements were becoming more understood, one great difficulty arose from the fact that they were regarded as some unusual form of strain, occasioned by a peculiar trauma, and at the same time the special influence of an atypical architecture of this joint group area was not given sufficient recognition. The ordinary joint strain has the potentiality for repair in a reasonable time, which improper or delayed treatment may retard or prevent. However, if these normal joints, the seat of strains, are given early treatment in accordance with the recognized methods,—rest, physiotherapy, fixation, and protection during convalescence—the same result is to be expected. Unfortunately, this frequently is not given, or not applied until after the disability has persisted and become semichronic, at which period the treatment must necessarily be modified.

CASES WITH ABNORMAL JOINTS

With abnormally formed joints, joints which show an atypical architecture, the problem becomes different and demands a modification of the prognosis and of the usual methods of that treatment which is ordinarily directed to normal joints. It can be considered that the presence of the

anatomical variations of the low back influences the problem of derangement of this area as an added potentiality of occurrence from the usual traumas experienced by the spine, and an obstacle which may retard the progress of recovery.

In the presence of an atypical structure, the essential question is whether such variation is a defect in architecture, introducing into the picture a potential or an actual weakness, or whether it is simply a variation in architecture. A departure from the usual is not necessarily a defect and does not necessarily carry with it an inherent weakness; therefore, to properly understand each case in order to direct the proper treatment, it should be immediately determined whether or not an atypical architecture is present.

Much has been written of the diagnosis, treatment, *et cetera*, of the non-pathological affections in this region, of the importance of these anatomical variations, and of the part they play in the etiology, prognosis, and treatment of these cases of derangement. These variations are exciting additional interest at this time, in part because of the bearing they may have on the problem of industrial injuries. The importance of the rôle which these variations play is yet a disputed question, and although so well recognized, still merits discussion. They may be grouped for this study of the low spine derangements as follows:

Character of Lesion		*Character of Spine*		*Location*
Strain Acute Chronic	in	Normal anatomical spines	involving	Lumbosacral joint
		Spines with anatomical variations Sacralized fifth lumbar Horizontal sacrum Imperfect articular facets Imperfect laminae		Sacro-iliac joint
Luxation (subluxation)		Pathological conditions of the spine Tuberculosis Arthritis Osteo-arthritis		Both the lumbosacral and sacro-iliac joints

In this discussion there will be considered only that group of cases in which this area is the seat of joint strain without a persisting subluxation, and those spines presenting some form of atypical structure; and they will be considered especially with reference to the involvement of the sacro-iliac or lumbosacral joint, or these three joints as a group.

The three well recognized anatomical variations in structure are: (1) the sacralized fifth lumbar vertebra; (2) the horizontal sacrum; (3) the irregular and asymmetrical lumbosacral articulation, with the defects of the laminae which so frequently are associated with this condition. Clinically, the cases do not present signs or symptoms by which these anatomical

defects can be satisfactorily detected, or sometimes even suspected, certainly not differentiated; only by the x-ray may the presence of these variations be established, but the importance of their influence on the prognosis and treatment cannot be disregarded. It is only by taking the types of architecture into consideration that the cases presenting themselves as derangements may be differentiated into their proper etiological groups, and the prognosis and treatment determined with these important influential factors in view.

(1) *Sacralized Fifth Lumbar Vertebra*

Since attention was first called to this variation, there has been much controversy as to its importance and as to the part it plays in the development of low back derangements. It is not necessary to describe the different forms of this anatomical type, familiar to all who are dealing with this problem,—they vary in the extent and firmness of attachment to the sacrum or ilium, and in the resulting solidity. One must distinguish between the enlargement of the transverse process with impingement on but with no actual articulation with the ilium, and the true sacralization with a true articular junction; and also between the unilateral and bilateral forms. Except that in the unilateral the firmer attachment of the sacralized process upon one side gives a lesser mobility or an added strength of attachment, the influence of this anatomical variation is undoubtedly very slight and rarely is an injurious factor. In the bilateral, the added articular areas result in a greater immobility of the junction,—but this loss of motion is easily compensated by the remainder of the lumbar region. In general, this anomaly is an element of added strength rather than weakness, and is not to be regarded as having the same importance as the anomalous variations which produce actual defects and which introduce a positive factor of weakness. The claim of added strain to the opposite side, in the unilateral forms, because of the firmer fixation on the side of the sacralized process, is mainly theoretical, for the remarkable mobility in the remainder of the lumbar spine easily compensates for the restriction occasioned by the sacralization. Of the different anatomical variations which are found in this part of the spine, this undoubtedly has the least influence in favoring the occurrence of or delaying the recovery from the usual derangements, and is of itself the least important. Much has been written on this subject, and of the rôle that this anatomical structure plays in the causation of strain, *et cetera*, but the consensus of opinion is very largely in favor of the view that its influence is negligible.

The derangements associated with the sacralized lumbar vertebra are similar in character to those met with in the normal spine, and the problem of their treatment is practically the same as with a low spine of normal anatomical structure. There is no tendency, because of an imperfect architecture, toward displacement or change of relation of the joints which comprise this group, and the possible unequal leverage, emphasized by some writers, is certainly not demonstrable and does not tally with clinical experience.

(2) *Horizontally Placed Sacrum*

With the normal degree of inclination of the sacrum, and normal angle of junction with the lumbar spine (160 to 140 degrees), the superencumbent weight falls to a firm and secure supporting base, with a minimum tendency of exaggeration of this angle and a minimum tendency of the fifth lumbar body to sheer forward on the sacral segment. The sacrum is described as having a forward rotation movement on an axis posterior to the body of the second lumbar vertebra,—the upper part of the sacrum tending to move forward and downward in response to the thrust of the superencumbent weight. In the normal angle this stress has a minimum of displacement force.

Fully as important is the relation of the sacrum in its attachment to the ilium. The ilium is hinged, as it were, to the sacrum on the horizontal axis by its attachment at the sacro-iliac joint, and this hinge forms a part of the supporting column, through which the superencumbent weight is ordinarily transmitted downward through these underlying sacro-iliac joints. The usual strain, therefore, in resisting the superencumbent weight is transmitted through a nearly vertical column, and is slight because of the minimum of the displacing force. However, with a change in angle, resulting in the forward inclination of the upper sacrum, such as exists in the horizontal type, and since, because of the displacement, the line of gravity is anterior to this sacro-iliac hinge, this tendency to the forward and downward thrust of the fifth lumbar vertebra is greatly exaggerated with the increased rotating force on the sacro-iliac joints. There results, therefore, an added force, exerting an abnormal strain on both joints in this group, of the character of a stress, to resist which their structure is not designed. In this respect the exaggerated angulation of the sacrum presents an actual defect of structure, and therefore an element of potential weakness, because of the forward and downward thrust of the upper part of the sacrum, which results from this displacing force. The resistance to this displacement of the sacrum must be met by the sacro-iliac joints, and in a position in which they are acting to a disadvantage. The weakness from this fault in architecture must be compensated by the additional ligamentous stress to resist a resulting twisting strain on a spine, not provided for by its anatomical structure.

Although this structure is entirely compatible with even an unusual physical activity, the horizontal sacrum has a two-fold injurious influence: (1) the anterior sheering force, as a consequence of the obliquity of the sacral segment in resisting the superencumbent weight, with the resulting tendency in yielding to the forward movement of the fifth lumbar vertebra toward a spondylolisthesis; and (2), most important, the twisting leverage force on the sacro-iliac joint, resulting from the forward and downward rotating motion of the upper end of the sacrum when the superencumbent weight falls forward of this joint instead of passing through it. This exerts a force which these joints are not constructed to withstand. The clinical significance of this potential weakness lies in the fact that this for-

ward inclination of the sacrum allows more easily the strain to be directed toward the sacro-iliac joints, which retards recovery, and renders these two joints more vulnerable to repeated strains, and thus it transmits the stress to the other joints in this area.

This is not to be confused with true spondylolisthesis, which is so often associated with this horizontal position of the sacrum, particularly when combined with imperfect articular processes, and defective laminae of the fifth lumbar vertebra.

(3) *The Irregular and Asymmetrical Lumbosacral Articulation*

The atypical lumbosacral articulation introduces a factor which always demands attention. The different variations have been fully described, and their types are well understood and need no elaboration. Differing from the other atypical structures, they always represent a departure from the normal or the usual, which is in some degree a defect in architecture, therefore a positive factor of weakness.

So frequently associated with these defects of this articulation are structural defects of the laminae, the importance of which is not in this lack of fusion of the laminae, but rather in the accompanying imperfect development of other parts of the neural arch not usually demonstrable by the x-ray. These defects frequently involve the articular facets, and also the supporting part of the lamina which forms their base. The defects of this area are seldom found isolated, but associated in different relations and degrees, and are particularly important because of the frequency of the imperfect development of the neural arch. The clinical importance of all, particularly when asymmetrical—which is usually the case—is in the diminished resistance to the superencumbent weight against the sheering forward to one side of the fifth lumbar vertebra,—a force which tends toward a rotation of the body, which in turn disturbs its relation to the supporting base. The importance of this yielding is in the rotation force which it transmits to the supporting sacrum, and which must be resisted by the sacro-iliac joints which hold it in position. This fact illustrates the principle that a yielding in one portion of this group results in an additional strain to be resisted by another joint of the group, and of a character and in a direction not usual to it.

Moreover, when this is associated with the horizontal sacrum, with its tendency to a forward and downward tilt, the result is an added twisting force on the sacro-iliac joint. Always in this lumbosacral junction is the tendency to forward displacement, against which the normal structure offers a strong and sufficient resistance. But, with the introduction either of a less perfect contour of articulation, or of the abnormal horizontal sacrum, or of both, there is added a potential toward an actual displacement, with the added ligamentous strain necessary to compensate the bony defect. When unilateral, as is ordinarily the case, this introduces the rotation element between the fifth lumbar vertebra and first sacral segment, and this displacement must be resisted by the supporting sacro-iliac joints

below. Again it is seen that the stress cannot be confined to one joint, but must necessarily be shared by those entering into this joint group.

In our present position, with accumulated experience of the few past years, recognizing its complicated clinical manifestations, the persistency of the symptoms and disability, it is necessary for us to look on this problem from a broad point of view, in order to estimate to what extent the majority of these cases are an affection of this joint group collectively, and how much they are an involvement of one joint alone.

Too much have these cases been regarded as a result of localized trauma, with closely defined identity, often as the strain of a special ligament or muscle attachment, with particular means of treatment directed to isolated and closely localized derangements. Even if these do exist as individual affections,—as is probably sometimes the case—it is a question whether it is possible to accurately diagnose or differentiate them, much less to apply special or specially directed treatment. At least in the vast majority of cases we are dealing with the complex result of a trauma, expended on a complicated joint area, which entire area must receive the stress, even if not yielding to it as a whole.

Certain facts must be taken into consideration. The problem is with a group of three joints, which, because of their close anatomical relation and common function, must be considered collectively and with reference to their inter-relation. Anatomically they are constructed to bear the same load, to distribute the stress more or less equally, and together they bear the shock. Functionally their work is the same,—to resist together and at the same time the great strain to which this special region is subjected, and which may come from any direction, since the strain which must be transmitted through this area must be borne by them all.

There is but little motion in two of these three joints, although sufficient to resist the usual stress or shock, which is transmitted from one to the others, and in which all participate. Because of the fact that in the two sacro-iliac joints the motion is slight, the capacity for resistance is less. They have in common ligaments to restrain the motion within the normal arc. Trauma exerted on one of these also must necessarily give stress to the others, even if not with injurious results. Yet repeated stress will tend toward a gradual yielding and the development of chronic derangement.

In the normal architecture their anatomical relations are such that the line of gravity coincides closely with their anatomical relations, and therefore the stress is borne with a minimum of mechanical strain,—*i.e.*, the architecture of the normal is sound, and constructed to bear the stress. On the other hand, with abnormal architecture the defect in structure introduces a loss in resisting strength, and since there is so slight a degree of motion—for the "take up"—all three of these joints must share in the stress. Particularly is the stress on the lumbosacral joint borne by either or both of the sacro-iliac joints, because of the leverage of the upper portion of the sacrum above its small attachment to the ilium.

The problem of diagnosis, with then the subsequent prognosis and treatment, is not simply that of the diagnosis of the presence of a sacroiliac or lumbosacral derangement. It should go further than this,—to determine, first, whether the derangement of this low spinal area is in a joint group of a normal structure or in a joint group possessing structural defects and with, therefore, a potentiality of incapacity; and, second, when an atypical structure is present, to what extent it exerts an influence on the incapacity of the whole of this group and may modify unfavorably the prognosis and treatment. Particularly in the lumbosacral joints the ligaments will yield, and leave a permanent residue of motion or laxity and a vulnerable joint. And, third, particularly is it essential, in this stage of our knowledge of the problem, to study each case from all angles, especially keeping in mind the fact that we are dealing not with the problem of an individual joint but with a group of joints, intimately related, anatomically and functionally, bearing the same stress, sharing the same strain, and frequently yielding as a group rather than individually; and which may, and often do, share in the involvement of the lesion. This is especially essential to keep in mind, since the two sets of joints comprising the group may produce signs and symptoms in common, and there is so much overlapping of evidence with the derangements of this area, that the prognosis and treatment must be based on this consideration of the close anatomical formation and the intimate functional character of this peculiar region, as well as of the cooperative manner in which each joint must resist the strains which come to this region as a whole.

THE DEVELOPMENT OF JUVENILE PES VALGUS

From the Krüppelfürsorgestelle of the City of Berlin in St. Hildegard's Hospital

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This article is based on material presented by Dr. Böhm at the *Kongress der Deutschen Orthopädischen Gesellschaft*, in September 1929, and published under the title of "Pes Valgus Staticus" in the *Zeitschrift für orthopädische Chirurgie*, LII, 424, 1929. This has been revised by the author for publication in *The Journal of Bone and Joint Surgery*, by arrangement with the editors of the *Zeitschrift für orthopädische Chirurgie*.

In the orthopaedic clinic we encounter a great number of "valgus deformities" of the foot under the generic name, "flat-foot". Hoffa attempted to clear up this jumble. He differentiated clearly between the true flat-foot in which the arch is flattened out, and the pes valgus or *Knickfuss*, as he called it, which appears to be twisted outward below the medial malleolus. This bending outward is a "pronation", the degree of which is determined by the extent to which the talus is tilted.

The *Knickfuss* may persist as such. It may, however, go on to the formation of a true flat-foot by the secondary depression of the arch. According to Hoffa this deformity of the foot develops at puberty, and is first observed then, in a large majority of cases. It is the most frequent form of flat-foot and so one of the commonest of deformities.

Since his time almost all writers have accepted Hoffa's conception of pes valgus. Several investigators — Hübscher, Hohmann, and others — have stated that pes valgus more often appears in early childhood and especially between the ages of seven and fourteen. According to the statistical investigations of Wassermann, Ewald, Henneberg, Kirsch, and others, which were carried out on thousands of children, more than fifty per cent. of them between the ages of six and sixteen showed a definite valgus deformity of the feet.

Hoffa designated this particular clinical entity which appeared at puberty as "static" pes valgus. Thereby he expressed the view of his time that *continual weight-bearing on the feet* was responsible for the deformity. In fact almost all investigators take it for granted today that external mechanical factors such as bad shoe designing, excessive weight, etc., are responsible for this deformity. But one cannot overlook the fact that only a certain number of human beings display this "*pes valgus staticus*". So there is a constant search for additional theories to explain the fact that only these individuals are affected. Every part of the foot has been implicated. Fascia, ligaments, and joint capsule have been thought to show atony. Muscles probably furthered the tendency to valgus during fatigue or sleep or through the imbalance of antagonists. Bones which had been softened by disease were thought to yield to the forces of weight-bearing. Finally,

such a purely mechanical factor as the habitual posture of fatigue has been given by several investigators as a satisfactory explanation for the origin of pes valgus. But none of the writers has offered an anatomical work in explanation of this or that theory of development.

After I had learned from my earlier work of the developmental basis for the origin of such deformities as genu varum and valgum, and pes varum, it followed naturally to look for a parallel cause for pes valgus.

The cases which one may term *secondary*, which are the result of trauma, —fractures, bone and joint disease, paralysis, etc.,—should be separated from "pes valgus" as a clinical entity. In addition to this first group, which is not very common, there is a second, the *rachitic*. Rickets often involves the leg just above the ankle joint and produces there a bending outward into varus. To compensate, the foot is turned into valgus. Finally, there is a third group,—the purely compensatory pes valgus which develops in connection with varus deformities of the lower extremities due to various causes.

FIG. 1

An illustration of "static" pes valgus.

If one separates these three groups from the rest, the truly idiopathic pes valgus remains. It appears chiefly at puberty, as Hoffa stated. It is more accurate to say that it is most noticeable at this time. It is apparent to a less degree during the entire childhood.

An analysis of the clinical picture of idiopathic pes valgus reveals the following facts. Inasmuch as the anomaly of the bones is distal to the knee joint (Fig. 1), the leg is best oriented so that the middle of the transverse axis of the knee joint (K) intersects a plumb line which is dropped from the middle of the hip joint (H). If H—K is prolonged distally, it does not run through the middle of the ankle joint as in the normal, but through the lateral part of it. Farther distally the line passes again through the middle of the externally apparent, posterior portion of the heel. The external contours of the extremity are normal as far as the middle of the lower leg. In the distal third of the leg there is a deviation toward the midplane of the body which becomes progressively more marked. There is a slight laterally convex curve above the ankle. The medial malleolus stands out prominently, while the lateral border of the ankle joint is flattened out. Like the medial malleolus, the region of the talus head and navicular is also prominent.

In a posterior view, one sees the well known relationships of the pronated foot. The tendo Achillis runs down vertically as though it were the string of a bow which is represented by the medial bowing of the talus and upper part of the calcaneus. The arch of the foot is well developed. There is no flattening and none of the frequently associated abduction and pronation of the part of the foot distal to Chopart's joint. To the contrary, there is often an elevation of the arch with supination and adduction. The deformity is rather sharply limited, therefore, to the region of the distal tibial epiphysis and the adjacent talus. We must look for the anatomical basis of the deformity here.

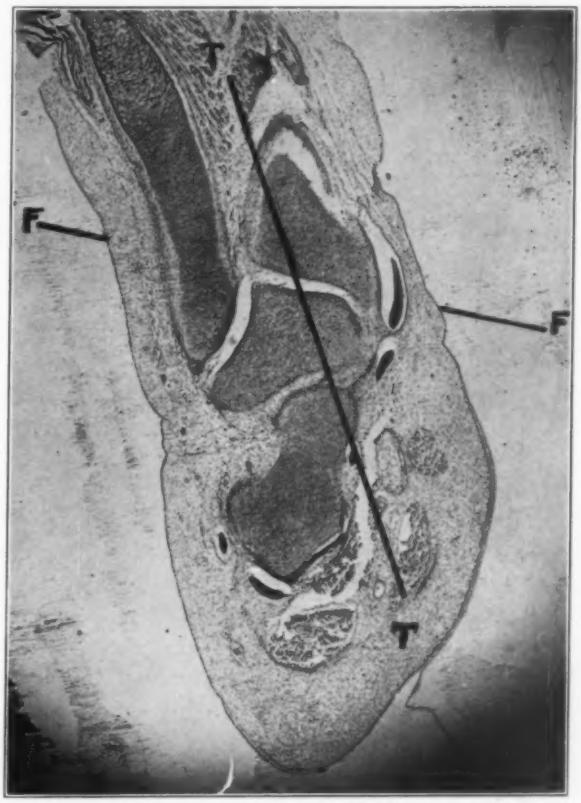

FIG. 2

Frontal section through the leg and tarsus of an embryo 35 mm. long.

With the assumption that we had a developmental anomaly to deal with, I next studied the normal development of the above mentioned parts of the skeleton.

A section (Fig. 2) through the ankle joint and tarsus of an embryo of thirty-five millimeters in the frontal plane gives one a particularly clear insight into the condition of the ankle joint. In this frontal section one observes the posterior (proximal) portions of the trochlea of the talus and the distal end of the tibia. The calcaneus and the tibia are cut about in the middle, between the proximal and distal halves. The tibia is seen only in part in the section because it slants ventrally just above the ankle joint. The adjacent fibula is visible for its entire length. By it the direction of the longitudinal axis of the lower leg (T—T) is easily determined. The peculiarity of the early embryonic ankle joint as pictured in Figure 2 is evident from a comparison with a section from an adult ankle. Such a section (Fig. 3) is reproduced from the textbook of Fick. It is made in about

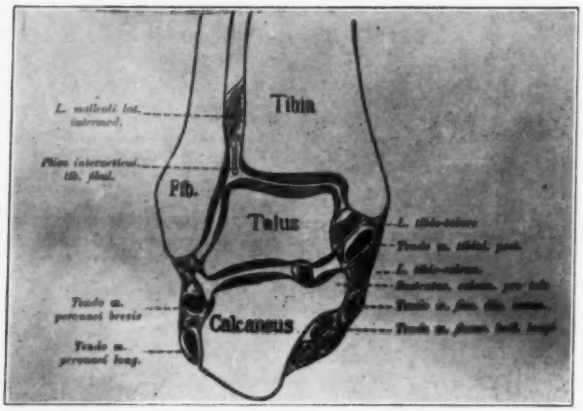

FIG. 3

Schematic frontal section through the leg and tarsus of an adult according to Fick.

the same plane as the one shown in Figure 2.

A comparison of the two shows several points of difference. In the adult the talotibial joint surface (*F*—*F*) is horizontal and perpendicular to the longitudinal axis of the tibia (*T*—*T*). In the embryo they intersect each other at an angle of about sixty-five degrees. In the adult the talus itself has in section almost the shape of a rectangle, while in the embryo it is that of a trapezoid. The sides of this trapezoid (Fig. 2) are disproportionate, the upper, tibiotalar joint line, being related to the lower, subtalar joint line, about in the proportion of one to one and five-tenths. The length of the lateral facet of the trochlea compares with the opposite side of the trapezoid, the medial facet, about as two to one. The relationship of the corresponding dimensions is quite different in the adult. The subtalar joint line is only a little longer than the proximal talar border. The length of the lateral (fibular) border is also only slightly greater than that of the medial.

A further, more important difference is apparent in the angulation of the talar borders which follows directly from the length relationships. While in the adult the lateral and medial joint lines intersect the talotibial line somewhat perpendicularly, in the embryo the medial joint line forms an obtuse, and the lateral an acute angle with this line.

The result of the peculiar relationships between the angles and lengths of the sides of the "talar trapezoid" of the embryonic foot is not only that the supratalar joint surface slants upward *laterally*, as above described, but also that the subtalar surface is higher *medially* than laterally. In comparison with the corresponding joint surfaces of the adult, the supratalar is pronated while the subtalar is supinated.

An important difference is also observed when one compares in the frontal sections the proximal joint surfaces of the *calcanei* which are adjacent to the tali. In the adult the line is about straight, while in the embryo it is more curved (Figs. 2 and 3).

The further course of development of the distal part of the tibia, the tarsus, and the joints on either side of the astragalus was studied in a whole series of foetuses varying from three to nine months. In order to determine accurately the direction of the individual axes of the bones and joints of the

tarsus during foetal development, Hans Virchow's method of "*Zusammensetzung nach Form*" was employed. The pelves and lower extremities were removed from the foetuses by a transverse cut through the lumbar vertebrae. A sagittal cut was then made in the midplane, dividing the distal portions into halves. Each half pelvis and extremity was then embedded in plaster so that the center of the femoral head and the center of the transverse axis of the ankle joint fell in a line (*H—H*) which was parallel to the midplane of the body. Thus a position was chosen for the foetal extremity which corresponded to the normal posture of the adult as given by Fick. At the same time care was taken during the fixation to preserve the indifferent rotation of the extremities. After they were embedded, the pelves and extremities were disarticulated and then laid back in the plaster molds.

As examples of several such preparations of foetal skeletons, Figure 4 is one of a foetus of about five months and Figure 5, one of a new-born. Both are in position in the plaster molds. For the sake of clearness, enlargements of only the distal ends of the bones of the extremities are shown in the pictures. The line of weight-bearing (*H—H*) is drawn in according to the original preparation. In the five months' foetus it runs from the middle of the femoral head along the medial border of the knee to the middle of the transverse surface of the ankle joint. In the new-born it passes through the medial condyle of the femur. It is at once apparent that the longitudinal axis of the tibia (*T—T*) is not coincident with the weight-bearing line (*H—H*) in the foetus as it is in the adult. Rather, it intersects it at an angle which opens laterally. In the five months' foetus

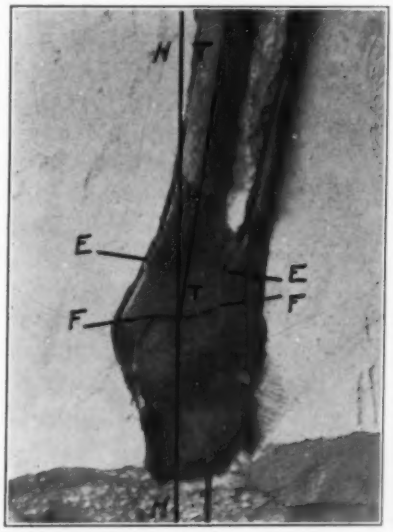

FIG. 4

The enlarged photograph of tibia, fibula, talus, and calcaneus of a five months' foetus reassembled in the plaster bed. The distal epiphysis is exposed by a cut in the frontal plane.

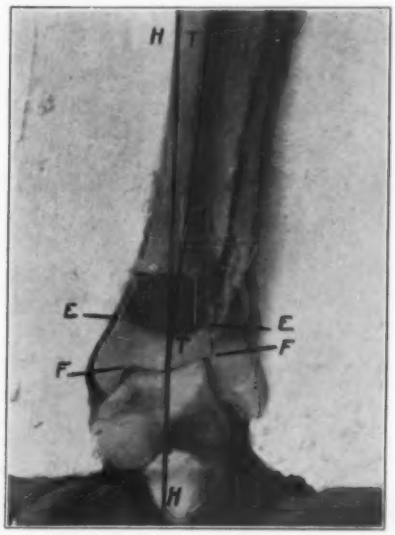

FIG. 5

The same preparation as in Fig. 4, made from a new-born.

this is about ten degrees and in the new-born five degrees. The surface of the ankle joint (*F—F*) is not perpendicular to the longitudinal axis of the tibia (*T—T*), but meets it at an angle which also opens laterally. In the five months' foetus it is about seventy degrees and in the new-born seventy-five degrees. Correspondingly, the angle between the weight-bearing line and the surface of the ankle joint is eighty degrees in both cases. It is therefore worthy of note that *the relationships of the surface of the ankle joint to the line of weight-bearing* remains about the same in the indiviudal foetal stages, but this is not true of its relationship to the longitudinal axis of the tibia. The younger the foetus, the more obliquely the tibia slants from lateral above to medial below, and the more the ankle joint tilts down on the medial side and up on the lateral.

In order to demonstrate the relationships of the epiphyses of the preparations shown in Figures 4 and 5, the anterior halves of the tibiae and fibulae were removed by a cut in the frontal plane exactly in the middle of the ankle joint. One can recognize the *epiphyseal line* and observe its advance from the fifth foetal month to birth. It is slightly arched, and its general direction (the cord of the arc *E—E*) is perpendicular to the longitudinal axis of the tibia. But inasmuch as the latter runs obliquely from lateral above to medial below, the epiphyseal line also slants downward laterally. The joint surface (*F—F*) just below it inclines on the lateral margin. Because of this, the distal tibial epiphysis in the foetus has the form of a trapezoid, *a wedge*, so to speak, *with a decrease in thickness laterally*. The younger the foetus, the more marked is the angulation of this wedge.

The bones and joints of the foot have at birth more than half completed the changes which take place during their development from the third embryonic month to the completion of growth.

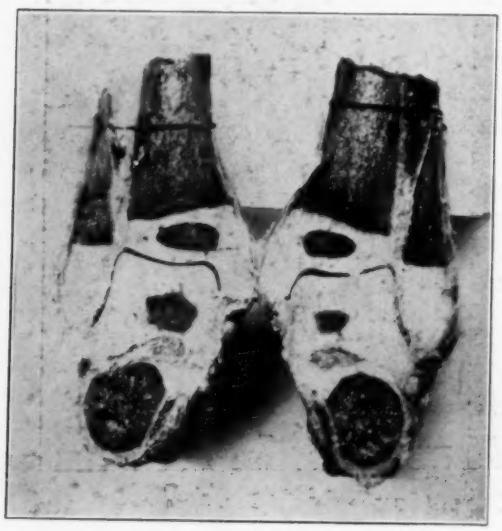

FIG. 6

The frontal section of the tibia, fibula, and tarsus of a one-year-old child.

During the first year of postnatal life the appearance of the distal end of the tibia changes very little from that in the new-born.

In the second year (Fig. 6) the osseous center appears in the distal tibial epiphysis. This is wedge-shaped in the front view. In Figure 7 is shown the tibia of a three-year-old child. It is laid open by a frontal cut through the middle of the ankle joint. The diversion of the epiphysis from the shaft medially, and the wedge-like diminution of its thickness laterally are ap-

parent. The form is the result of the lateral inclination of the joint line and decline of the epiphyseal line. *It is worthy of note that the borders of the osseous centers conform strictly to those of the cartilaginous epiphyses.* Conversely, one may outline the contours of cartilaginous epiphyses in the living (with the aid of roentgenograms) by observing the shape of the centers. In particular one may judge as to the position of the joint surfaces which are actually not apparent in the roentgenogram.

I have a preparation taken from an eight-year-old child (Fig. 8) for which I am grateful to my collegue Dr. Harrenstein of Amsterdam. The slight wedge shape of the epiphysis, the lateral inclination of the joint surface, and the height of the lateral facet of the talus evidence a similarity to the embryonic relationships.

Finally, the roentgenogram of the isolated tibia of a ten-year-old child is shown (Fig. 9). The picture was taken with the transverse axis of the distal tibial joint surface horizontal (without rotation), with the central ray focused on the center of the transverse diameter of the joint. The epiphysis is essentially rectangular. One can see three lines in the roentgenologic projection, the anterior and posterior lips, and the true joint surface (*g*). The last must be considered in judging the form of the epiphysis.

On summarizing, the following can be stated with regard to the development of the distal tibial epiphysis and the neighboring bones of the tarsus:

Even though the bones of the foot consist largely of soft elastic cartilage during prenatal life and as a consequence the external appearance of the foot varies greatly, there is nevertheless an inherent and typical foot form for this period. In this article I have begun with the second month of embryonic development because I have given a detailed account of the stages and foot forms of the early period in my article on congenital club-foot.

From the third month

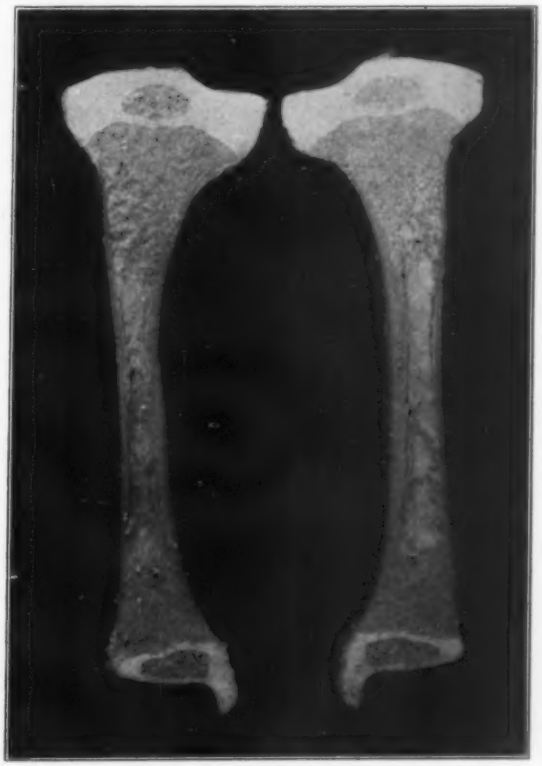

FIG. 7

The frontal section of the tibia of a three-year-old child.

until after the time of birth the human foot assumes a form which is considered a club-foot or "club-foot position" by one group of authors and a flat-foot by another. In the light of my investigations one can understand how such apparently contradictory conceptions can arise. The foot of the foetus or the new-born has a very peculiar shape which is characterized in orthopaedic terms as a pes valgus of the ankle (talotibial) joint and a pes varus of the talocalcaneal joint. Each "malposition" compensates for the other, and together they establish the normal relationship of the tarsus to the line of weight-bearing, with the bony parts arranged equally on either side of this line. In the course of prenatal and postnatal development, the ankle joint loses its valgus, just as the distal joint loses its varus. The attainment of the ultimate "normal form" is only possible, however, when the transformation in *both* joints is coordinated. The degree of change must finally be the same and so the compensation be complete. If, for example, only the *ankle joint* progresses normally in its development while the talocalcaneal joint is retarded, a club-foot position results (not a severe club-foot of course). Inversely, *if the ankle joint does not continue to develop but the distal joint undergoes the normal transformation*, a pes valgus is evolved.

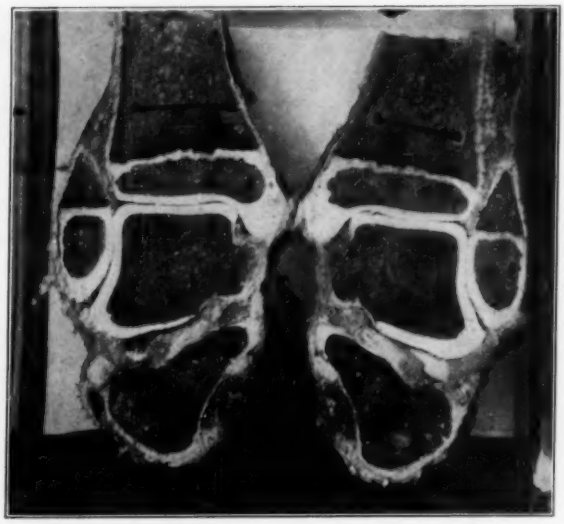

FIG. 8

The frontal section of the tibia, fibula, and tarsus of an eight-year-old child.

FIG. 9

The roentgenogram of the tibia of a ten-year-old child.

In order to study the skeletal relationships in the so called "static" pes valgus, I have x-rayed many such cases. The pictures were taken in the anteroposterior view with the central ray accurately focused on the middle of the ankle joint. The foot was rotated exactly forward and bent to a right angle where it was held in position by a rectangular block of wood during the process.

In Figures 10, 11, and 12 such roentgeno-

grams are reproduced. They are from children of ten, eleven, and twelve years respectively. All three show the same characteristics. The longitudinal axes of the shafts of the tibia and fibula run obliquely from lateral above to medial below. The medial border of the tibia is more sharply curved than normal in its distal third. The epiphyseal line is about perpendicular to the longitudinal axes of the shafts, and therefore at an angle to the line of weight-bearing (from medial above to lateral below).

The medial malleolus is more prominent than it should be at that age. *The tibial joint surface as defined in the roentgenologic projection by the line before described* (see above) *runs obliquely from medial below to lateral above. The epiphysis, therefore, decreases considerably in size toward the lateral side.* In the illustrations one observes the slight elevation of the lateral border of the trochlea which would probably be exaggerated if the picture were taken during weight-bearing.

The roentgenologic study of these cases, which are cited merely as examples from among many others, discloses an anatomic condition similar to that which may be demonstrated in the embryonic and infantile foot.

FIG. 10

The roentgenogram of a case of clinical "static" pes valgus in a ten-year-old boy.

FIG. 11

The roentgenogram of a case of clinical "static" pes valgus in an eleven-year-old boy.

FIG. 12

The roentgenogram of a case of clinical "static" pes valgus in a twelve-year-old boy.

This analogy suggests the conclusion that idiopathic pes valgus is the clinical manifestation of a developmental arrest. This conclusion is supported by the fact that the deformity in question shows a very definite hereditary and familial selectivity.

On the other hand one must not overlook the possibility that the wedged distal tibial epiphysis of pes valgus may be a secondary condition,—that is, a mechanical deformity resulting from an abduction of the foot caused by other factors. In order to investigate this question, roentgenograms were taken of feet in which the abduction must be classified as compensatory because of the simultaneous occurrence of a varus deformity of the upper or middle part of the leg. Although a very exaggerated abduction was present in the foot itself, the roentgenogram did not show the typical wedging of the epiphysis above described. Even in outspoken rachitic pedes valgi, in which the epiphyseal borders were very irregular, there was no wedging.

A case is presented in conclusion which is relevant only in that it demonstrates the causal relationship between a wedge-shaped tibial epiphysis and pes valgus. It is a case of multiple exostoses with high grade pedes valgi (Fig. 13). The roentgenogram of the ankle joints (Fig. 14) shows the phenomenon of *wedged epiphysis formation adjacent to the exostoses*. The two abnormalities doubtless have a similar cause, but this is not of immediate concern. The important fact is that the wedge shape of the epiphyses can here be roentgenologically established as the anatomical basis for the extreme pedes valgi.

FIG. 13

Pedes valgi in a ten-year-old boy (with multiple exostoses).

In the light of anatomic and embryologic studies I account for idiopathic pes valgus on other than a static basis. All children are born with the *ankle joints* in

valgus. This persists during childhood but decreases in amount. It is not noticeable, or only very slightly so, however, because of the coincident varus in the *talocalcaneal* joint which maintains the foot in the vertical position.

If the valgus in the region of the ankle joint persists as a result of a developmental arrest, while the varus of the distal joint is gradually transformed into the normal position, the compensation is insufficient or lost and a clinical idiopathic pes valgus appears. The less this varus is able to compensate, the more extreme is the deformity. Due to a retardation at a very early stage of development, the valgus of the ankle joint may also be so marked that complete compensation is impossible.

All of these facts are in accord with the time at which idiopathic pes valgus appears clinically. At puberty the varus of the talocalcaneal joint normally disappears, so that this element of compensation is lost. Then any abnormal valgus becomes especially noticeable.

By the *pronation at the ankle joint*, the whole foot, and especially the tarsus, is placed obliquely on the leg. A valgus of the tarsus develops necessarily. But this is exaggerated by the curve of the tibia. Retarded development has resulted in a varus deformity of the distal part of it and the foot is forced still more into valgus to compensate.

FIG. 14
The roentgenogram of the case in Fig. 13.

So do static forces work on the building stones of the foot. In this abnormal condition the plastic material is defective and during development the deformity is progressively exaggerated.

Now we can apply the rules which v. Meyer, Lorenz, and others laid down with regard to the static development of flat-foot. And so as a result of faulty development we have the deformity of pes valgus idiopathicus or adolescentium or "staticus".

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TUBERCULOSIS OF THE SYMPHYSIS PUBIS

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The author desires to report this case for two reasons: first being the fact that very little attention has ever been paid to tuberculosis of this region; and second, that the particular case to be reported gave evidence of numerous points which are unusual and which also are of value in other conditions as well as in the study of this particular lesion.

As has been stated, there has been very little in the literature on this subject; as far as can be ascertained Hennies was the first to report tuberculosis of the symphysis, in an inaugural address given in 1888.

During the last fifteen years several men have written on this subject and it would seem well in the light of the author's case to report in part the findings of these men:

In 1890, Chauvel reported a case in a man of twenty-three in which nearly all of the symphysis was removed in the form of a sequestrum; the end result is not known.

In 1902, Herz reported two cases—ages eighteen and fifteen—both were treated surgically; one died. This death was due to the fact that the process had extended to a marked degree before operation was allowed. He mentioned difficulty in walking as an early symptom.

Just prior to 1902, Krause reported two cases of abnormal motility in the pelvic bone following tuberculosis.

In 1905, Tillman reported a case in which there was marked disturbance in gait and stated that surgical treatment was the only worthy procedure.

In 1907, Woloch reported a case of a woman of sixty-three who eventually recovered following an extensive operation. He stated that because of the scarcity and vagueness of the symptoms the cases are seldom diagnosed until the appearance of the fistula.

In 1913, Mario published an article which, in abstract, gives the following information:

His patient was a young woman of eighteen; parents living and well; a brother died of tuberculous meningitis at five years of age; patient had had the usual diseases of childhood and occasionally bronchitis in winter. Recently she had had loss of appetite, weakness, pallor and loss of weight. Six months prior to admission to the hospital she had slight evening fever. The physician who was called found a suprapubic tumor and sent her to the hospital.

Examination showed pallor of the skin and mucous membranes; thoracic organs normal; liver and spleen normal in size. Inspection showed a medium tumor in the hypogastrium covered with a normal skin, which did not seem to be connected with the pubis as there was a slight depression in the wall of the abdomen toward the pubis and the tumor did not change in position, size, or form, on change of position of the patient or on

deep inspiration or expiration. The tumor was ovoid and symmetrical, the size of an ostrich egg, with its largest diameter vertical. It was twenty centimeters long and twelve centimeters broad. Its lower boundary could be felt just back of the pubis and its upper one four centimeters below the umbilicus. It was fluctuating, painless, and immovable, and its lower termination could not be found on deep palpation. Vaginal exploration was not allowed but on rectal examination a tumor could be felt above the genitals which corresponded in size and consistency to the one seen on inspection. The inflammatory nature of the tumor was evident from the rise in temperature and the condition of the tissue but it was hard to determine its site.

A medium subumbilical incision was made and a liter of thin purulent fluid was found in a cavity bounded posteriorly by a triangular fibrous layer, the base of which was inserted in the posterior lip of the symphysis, and anteriorly by the tendon of the pyramidalis and rectus muscles which are inserted into the anterior lip of the symphysis. This space was triangular in form with its apex toward the umbilicus and its base toward the pubis. After having emptied the cavity of its contents its upper and lateral walls were found to be formed by reddish pyogenic membrane; below toward the pubis this cavity communicated through an opening five millimeters in diameter with another small cavity, and the two were placed in free communication by incising the upper ligament of the pubic joint. A finger could then be passed into the smaller cavity, which contained pus of the same character as that in the upper cavity but denser. This small space was rectangular in form with its sides formed by the surfaces of the pubic bones, which were not covered with cartilage at all, but were normal in appearance. It was bound in front, behind, and below by the anterior, posterior, and inferior pubic ligaments covered with fibrinocaseous exudate. This cavity was emptied and the caseous masses curetted out. Both cavities were disinfected with zinc chlorid and drained with iodoform gauze. There was an uneventful recovery.

The tuberculous nature of the lesion was proved by positive inoculation into a guinea pig.

In this case Mario evidently expected to get complete welding of the pubic bones.

In 1914, Büngner reported on this subject as follows:

His case was that of a woman of fifty-seven who entered the hospital in February 1898. Since October 1891 she had noticed a tumor the size of the fist in the lower part of her abdomen which had not caused any pain but had continued to grow.

Examination showed a soft tumor eighteen centimeters long under the skin of the mons veneris which occupied the pubic and inguinal regions and extended downward below them. There was deep fluctuation but the author had some doubt as to whether it contained liquid. Vaginal examination showed that the tumor was not connected with the internal genitalia. Palpation of the symphysis and lateral compression of the pelvis did not cause any pain.

Operation was proposed and refused; but the patient returned to the hospital in April of the same year.

Her general condition which had previously been good had changed greatly for the worse. She said that three weeks before a tumor had opened on the left side and afterwards one on the right. The tumor had increased in size laterally and upward. There were fistulas in the lateral parts of the tumor, which had the appearance of being tuberculous. Exploration with a sound showed undoubted denudation of the periosteum and caries of the symphysis.

Operation was performed. The pus cavity was opened and found lined with lardaceous tissue. The bottom of the cavity contained carious bone. All of the diseased bone and three centimeters on each side were removed with a Gigli saw. The specimen included the symphysis—which had been destroyed. In the right side there was a sequestrum the size of a large nut which corresponded to the descending ramus

of the pubis. There was also a cavity there the size of a dove's egg lined with tubercular granulations. There were osteophytes around it. The cavity was curetted carefully and tamponed with iodoform gauze.

In this case Büngner stated the woman was finally discharged apparently well without any abnormalities palpable over the symphysis.

Büngner also reviewed the cases of Hennies, whose first article was written in 1888:

At first the man complained of intense pain in the lumbar region and about the same time a fistula appeared in the horizontal ramus of the pubis on the left side. The fistula was incised and his condition grew worse. This man was operated upon and the horizontal rami of the pubis were cut on both sides at the obturator foramen and the bone between them removed, leaving only a little of the ascending rami. This cavity gradually decreased in size and the patient finally was discharged as cured in three months' time.

The second case reported by Hennies was a man of fifty-eight who complained of intense pain beginning in the right inguinal region and radiating down into the thigh; later this pain became localized just above the symphysis where a tumor appeared. This tumor was diagnosed as a hernia, and after wearing a truss two weeks, the tumor became bluish red and fluctuation appeared. It broke spontaneously—this was definite tubercular pus.

Operation was finally done on this man; and at the angle of the pubis a movable sequestrum the size of a large chestnut was found and immediately removed; a second sequestrum the size of a phalanx was found and also removed. Five months later the man was discharged cured.

The third case was a woman of seventy-three who began to have a feeling of weight in the pelvis; no pain; later she had violent rheumatism which left her in a weakened condition. The next year she noticed a tumor in the right inguinal region which grew to the size of a hen's egg; finally two years later, when admitted to the hospital, two large tumors above the symphysis were found.

On operation definite tubercular pus was found and a cavity divided into three compartments was exposed, situated between the superficial fascia and muscle. The bone was curetted and the cavity tamponed with iodoform gauze. The patient was discharged the following month in good condition.

Büngner stated that tuberculosis of the symphysis is more frequent in women than in men and in adult life than in childhood; this is probably due to the fact that children do not have the fibrocartilage of the symphysis and that this cartilage is larger in women than in men. Trauma affects also, as it does all tuberculous processes. Sometimes the process originates in the fibrocartilage and sometimes in the bone. It makes little difference which is the origin,—the final result is erosion and sequestra of the symphysis. These processes appear above the symphysis or behind it; they may appear in the inguinal region, but rarely on the perineum or thigh.

Prognosis is benign as far as the pubic process is concerned; the only danger is extension to other organs. The treatment is surgical and the results better if it is early. The cavity should be thoroughly curetted and tamponed. Cure without recurrence was noted in all cases by this author.

In 1922, Rendu and Wertheimer reported a case of a boy nine years old.

The first symptoms in this case were swelling on the internal and upper part of the left thigh. The x-ray showed an osseous lesion on the internal portion of the descending

ramus. Operation was performed, which consisted of a curettage of the entire area. At the time of the report the boy was on the road to recovery.

In 1923, Reich reported a case of caries of the symphysis.

The patient, a woman, fifty-three years old, entered the hospital because of diarrhoea and severe loss of weight, stating that she had a tumor in the region of the symphysis and that she experienced pain, especially when rising from a recumbent position. This woman refused surgical operation and finally died of pneumonia. At autopsy caries of the symphysis and adjacent parts of both pubes was found.

Reich summarizes by stating that bone caries of the symphysis is characterized by sharply defined defects with absence of atrophy. Healing takes place by the defects being encapsulated with calcium but never being filled in. Osseous neoformation may appear in the neighborhood, especially in cases of long duration. Peripheral osteoplastic sarcoma and osteochondrosarcoma differ little in x-ray findings and it is therefore very difficult to make a definite diagnosis.

He emphasizes the necessity of taking into consideration the possibility of tuberculosis whenever these lesions are found, even in cases of atypical localization.

In 1923, J. B. Jackson reported a case of tuberculosis of the symphysis in a girl eleven years old.

A few weeks before her first examination the family noticed an unusual gait with difficulty in walking and running and soon afterward a swelling appeared on the anterior surface of the right thigh below Poupart's ligament. The x-ray first called attention to the symphysis pubis. The treatment was non-surgical and no end result was noted. The girl was given direct sunlight treatment and the abscess was aspirated several times.

In 1923, Swynghedauw and Druon reported a tuberculosis of the symphysis. They comment on the etiology as did Büngner, except that they state that sex seems to have no definite influence and that age is variable. They also state that traumatism is not a likely factor as the pubis is not much exposed to violent blows, and because some of these lesions have appeared on the posterior surface.

As to symptoms, they state that the onset is frequently insidious and there is practically no pain at any time; in a few cases there was spontaneous pain at the symphysis, while in other cases pain was felt at more or less distant points. Disorders of gait are extremely rare; some patients become fatigued. The first objective symptom found was often a tumor. Their comment on treatment is that operation is easy and usually necessary.

They review thirty-three cases, in which there were nineteen cures and five improvements; in four cases results were not mentioned, and in four cases negative results were obtained.

In 1924–1925, Clairmont reported an operation on a woman of twenty-eight, who was admitted complaining of pain and swelling of the pubic region—more especially on the right. At operation a radical excision of the whole infected area was performed, including the right half of the symphysis.

At the time of operation there was considerable criticism that the operation was unnecessarily drastic, but Professor Clairmont disagreed, and stated that in his experience only the widest possible excision was sufficient.

In summarizing these cases which have been mentioned: First, as to etiology, the claims as to trauma seem to be of little value—only one man having stated that trauma plays an active part in the condition.

From the ages which were mentioned in these cases it is certain that tuberculosis may appear in the symphysis pubis during any age of life, in spite of the fact that Büngner said that the histological structure of the symphysis would prevent tuberculosis in children; neither does sex have any bearing on the question.

A study of the symptomatology brings out two rather definite findings, —*viz*, an irregular gait and a tumor mass. This tumor may be localized about the symphysis or appear in the upper thigh. No other symptoms seem to be present so frequently as these two. Of course when a fistula appears the diagnosis is rather easy. There is little help in differential diagnosis in this condition. From the cases which have been reported it would seem best to consider caries before any other lesion.

When we come to the matter of treatment, it should be noted that all cases previously reported have had surgical drainage in one way or another, curettage and excision playing the most important rôle.

As to prognosis, it is impossible to say anything definite because in no case was there any mention of how much disability was present or whether this disability was localized over the symphysis or in some other region; this is perhaps due to the fact that these cases were rather acute and treatment consisted of drainage of the abscess with the hope that union might be completed.

The following case is reported, because it is considerably different from the cases previously mentioned. In addition, the author failed to find this lesion during the first several months of trouble, due to the remote character and vagueness of the symptoms.

A girl of twenty-three came to the office in December 1925. She stated that as a small child, while living in a small town on the coast of Massachusetts, she had a chronic fever and was incapacitated in bed over a long period of time. This was prior to the days of x-ray and no definite diagnosis was ever made. She got well, however, and for two or three years previous to 1925 had been working for the New England Telephone Company.

About a year prior to her visit she had been having pain in the lower back, with sciatica. There was a peculiar fact about this sciatica,—*viz*, that sometimes she would have it in both legs and then it would shift from one to the other and she would also have periods of complete remission of symptoms.

She had noticed that of late she had been limping, and finally the pain became so bad that she reported to the telephone company and was sent for examination. X-rays of her back taken in Boston showed an old tuberculous lesion of the dorsal region. She was told that this accounted for her trouble and was referred to the writer by her family physician.

On examination, she was found to be a well developed and well nourished young woman; general physical condition being most excellent. There was a slight kyphos in

the lower dorsal region but no muscle spasm or tenderness was found. There was a slight local splinting in this region without any general limitation of motion. There was considerable tenderness over the right sacro-iliac joint; compression of the ilii produced no pain; compression of the symphysis pubis caused no pain in that region or in the back. Straight leg raising was perfectly normal without pain; posture good. A diagnosis of sacro-iliac strain was made and a corset was recommended. It was noted at that time that the lesion in the dorsal region was not causing the symptoms.

Early in 1926 she was still having some discomfort and a shingle splint was added to the corset. Later on she telephoned that her pain had entirely disappeared and she was feeling fine.

In February she returned complaining of soreness in her left lower quadrant and in her left leg posteriorly. After home treatment of a purge followed by an enema, this pain disappeared and it was decided to try manipulation of her back and stretching of the leg. This was continued over a considerable period of time with complete relief from all symptoms until late in February, when she slipped on the ice and had more pain.

Manipulation was continued and in addition she was given exercises and was finally discharged March 20, 1926, as physically fit again.

She returned June 12 of that year complaining of pain in the region of the right sacro-iliac joint with tenderness in the lower abdomen. Rest in bed for a short period of time helped her back, but did not help the abdominal tenderness, and she was referred to a surgeon with a question of helping the disorder. She was found to have a retroverted uterus and, due to the fact that she had so much discomfort, operation was advised. Just prior to the operation an x-ray was taken of the lower back and sacro-iliacs and there was a peculiar shadow noted for the first time in the symphysis and the bones adjacent to it. The x-ray was not particularly good. Having this in mind, the author was allowed to assist in the abdominal operation in order to palpate this region. Palpation revealed nothing abnormal. The pelvic organs were normal in color and a moderate retroversion was found with no evidence of any enlargement in or about the symphysis; no bone roughening or softening.

She recovered well from her operation, after the suspension was done, and was completely relieved from all symptoms until December 1926, at which time she reported, complaining of recurrence of her pain and her sciatica. There was a decided limp and her symptoms were localized in the right sacro-iliac joint. X-rays were taken at this time which showed a definite destructive lesion in the left symphysis pubis. It was impossible to say whether this was an osteitis fibrosa with a cyst or a tuberculous disease. Careful examination of the parts involved, at this time, failed to reveal any swelling or loss of bone substance, and the amount of tenderness on the left ramus was slightly more than on the right.

A question of operation immediately appeared and a consultation was requested. Dr. Mark Rogers, of Boston, was called in consultation. It was finally decided that her symptoms required some form of fixation in front, and operation and bone graft were advised. March 9, 1927, an operation was performed with the assistance of Dr. Rogers.

A transverse incision over the symphysis was made and the pubis exposed; the superior margin of the symphysis was found intact, but on careful finger exploration a large cavity was exposed extending downward into the labia on the right side. This cavity was filled with a thin serous fluid which was clear. Two large sequestra were found in this region floating free in the cavity; and it was discovered that the inferior margin of both rami were gone obliquely in the lateral plane toward the inferior angle of the descending ramus,—this accounted for the sequestra. The whole cavity was lightly curetted, and on the supposition that the cause was osteitis fibrosa with cyst degeneration, a bone graft was applied across the horizontal portions of the pubis, and the wound was closed without drainage and double plaster spica applied.

The wound healed by first intention, but about five weeks later a small bleb appeared at the left extremity of this scar, which was opened and a small amount of serous material

obtained. This wound healed readily. Since that time the scar has remained solid. No complications were found.

She remained in the hospital approximately twelve weeks in a recumbent position and then another month at home in bed. She was fitted to a corset and belt which she is still wearing. For a while after she began to get on her feet she had some sacro-iliac soreness; this has gradually disappeared. From time to time x-rays have been taken of this region and they show gradual obliteration of the cavity and absorption of the graft.

About January 1, 1928, she returned to her work and has been getting along without any discomfort ever since. She is extremely active and is continually going about to dances and on long walks. She has put on considerable weight and feels fine; her only complaint being occasional soreness in the region of the scar on her left leg from which the graft was removed.

Prior to her operation, when a graft was mentioned, she was told definitely that if she ever got married and had children they would have to be by the Cesarean route.

Conclusion: The sequestra were examined at the laboratory associated with the Deaconess' Hospital in Boston and a report of "tuberculosis" was made. This came as a surprise in view of the findings at operation and there was a question as to whether the graft would survive.

It was impossible to state definitely at what time this tuberculosis appeared in the symphysis. There is no doubt but that the long continued fever was due to tuberculosis, but whether of the spine or pubis or both it is impossible to say.

There is no doubt but that this lesion had been present for a great many years. A noteworthy fact is that at no time did she have any definite symptoms in this region but her symptoms were entirely mechanical,—*viz.*, due to lack of fixation in front, a strain had been put on both sacro-iliac joints and it was this strain that had bothered her—nothing else.

A surprising feature of this case is that after the destructive process was noted in the symphysis, the original x-rays were examined and the same process found. This had completely escaped the roentgenologist, and at the first operation through the abdomen palpation of this region was entirely normal.

The experiences in this case lead the author to state that in all cases of sacro-iliac lesion, inguinal pain, lower abdominal and upper thigh tenderness, x-rays of the symphysis pubis should be included before treatment is considered; that in cases where there are acute symptoms, curettage should be instituted, with fixation later when the wounds are healed.

In the absence of much bone, a graft is the only procedure which can give proper fixation, and is justifiable at any age, if mechanical treatment,—such as corsets, belts, and braces—does not prove sufficient; and finally, with fixation a definite and complete cure can be almost guaranteed.

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THE DETAILED CHANGES CHARACTERISTIC OF HEALING BONE IN AMPUTATION STUMPS

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INTRODUCTION

In a previous report on immediate and eventual features of healing in amputated bones[1] we have shown some of the general changes occurring in the process of repair. The present paper deals with more detailed changes seen in bones at the site and in the immediate vicinity of amputation. For the most part the specimens used are those of the previous report but, whereas formerly we were occupied with the general features, we now purpose to describe in detail the technical process of repair.

SIX DAYS

The earliest stage of reaction is seen in our specimen W. R. U. 262, male, white, age about forty years, an amputation through the upper third of right tibia and fibula not more than five or six days after operation. The changes seen in this specimen are so slight that they doubtless would have been overlooked had it not been for the erosion of cortical bone demonstrated by the roentgenogram. Indeed this erosion is so slight that only on magnification are definite areas of increased vascularity and accompanying erosion, partially obliterating the saw marks on the cut face, to be seen (Fig. 1-A). Molecular erosion not accompanied by an increased vascularity also results in a rounding of the cut margins (Fig. 1-B). The snail-track type of molecular erosion, which is so characteristic of commencing sequestrum formation[2], is apparent upon the subcutaneous surface, though it is not extensive (Fig. 1-C).

ELEVEN DAYS

The next specimen W. R. U. 864, male, negro, age forty-eight years, is an amputation through the mid-shaft of the right tibia and fibula about eleven days after operation. The cut faces show plainly the saw marks of a recent operation. These markings are being obliterated by a molecular erosion without obviously increased vascularity. The margins also show molecular erosion clearly and present an appearance as of wax somewhat melted by the heat. The erosion is unequally progressive over the cut face; it is most marked in those parts which, owing to thin substance or final operative fracture, have been least injured. They are also quite

FIG. 1-A

Sawn surface showing partial obliteration of saw markings by erosion and vascularity.

FIG. 1-B

Molecular erosion of raw bone edges on both sides of accidental adventitious saw cut, subcutaneous surface.

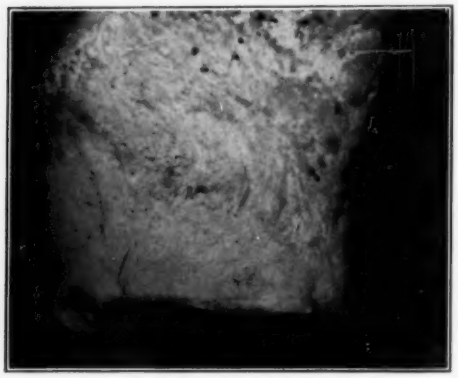

FIG. 1-C

Snail-track type of molecular erosion characteristic of superficial scaling sequestrum formation.

FIG. 1

Amputation right tibia. W. R. U. 262. Male, white, age about 40 years. Amputation upper third 5 or 6 days previously.

vascular. It is true that in the thick subcutaneous face and ventral margin a chronic inflammatory area is present, which has become involved in the recent vascular activity called forth by the surgical treatment (Figs. 2-A and 2-B).

There is internal callus in both bones. In the tibia it is flush with, but in the fibula it is somewhat proximal to the cut face. The callus itself is very porous but intimately united to the cortex. In both bones it is most abundant in those areas where the cortex is thinnest.

There is no external callus evident on either tibia or fibula. Increased vascularity with its accompanying erosion is erratically present on the outer surface of the shafts adjacent to the amputation faces.

THIRTEEN DAYS

Left femur W. R. U. 319, male, white, age fifty years, is an amputation through the mid-shaft some thirteen days after operation (Fig. 3). Erosion has obliterated all evidence of saw marks on the cut face. Toward the periphery a type of erosion, obviously accompanied by an increased vascularity and of a much rougher character than in the preceding specimen, has resulted

FIG. 2-A

Cut face of bones.

Note greatest erosion on fractured posterior area of tibia, next greatest on thinner portions of shafts. There is an area of erosion and vascularity in front on the tibia which is due to the wakening up of a previous inflammatory reaction. The internal callus springs from the thinner areas of shaft in each bone.

FIG. 2-B

Lateral aspect of fibula.

Note snail-track characteristic of flaking sequestrum formation.

FIG. 2

Amputation right tibia and fibula. W. R. U. 864. Male, negro, age 48 years. Amputation through mid-shaft about 11 days previously.

in a marked rounding of the face margins. The same type of erosion also plainly involves the outer surface of the adjacent shaft. Internal callus, though not abundant, completely surrounds the medullary cavity. It is quite thin except in the area adjacent to the linea aspera, and though intimately united to the cancellous tissue, is more porous and easily differentiated therefrom.

A small amount of external callus is seen on the posterior surface of the shaft just medial to the linea aspera. This callus being new is very porous in texture and the subjacent cortex is eroded to a greater degree than elsewhere at a similar distance from the cut face.

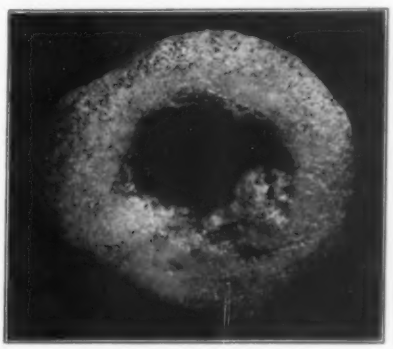

FIG. 3

Amputation left femur. W. R. U. 319. Male, white, age 50 years.

Amputation middle third about 13 days previously.

Note general erosion especially of margins with increased vascularity and internal callus.

FIFTEEN DAYS

W. R. U. 1019, male, white, age fifty-eight, is an amputation through the lower third of the right forearm some fifteen days after operation.

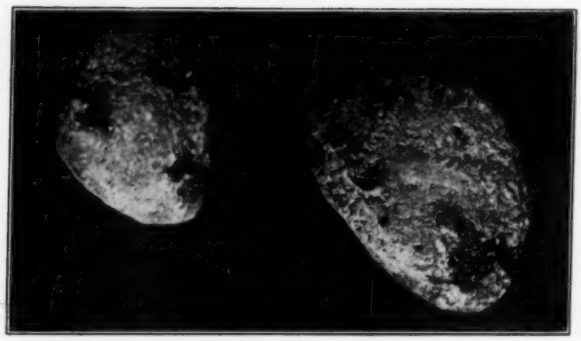

FIG. 4

Amputation right radius and ulna. W. R. U. 1019. Male, white, age 58 years.

Amputation about 15 days previously through lower third of shaft below marrow cavity. Original cancellous tissue completely closes cut end. Erosion of cortex with commencing waxy transformation of vascularized bone indicating quiescence.

The amputation severed both bones below the marrow cavity and the cancellous tissue of the shafts shows condensation greater than in the preceding specimens, so that it is not easily distinguishable from the surrounding eroded cortex. There are local variations in density of the cancellous tissue of both radius and ulna.

Molecular erosion has to a moderate degree rounded the cut margins of both bones and irregularly involved the adjacent shafts (Fig. 4).

There is a moderate amount of external callus with erosion of subjacent cortical bone on radius and ulna alike.

SEVENTEEN DAYS

Right femur W. R. U. 1585, male, negro, age thirty-one years, is an amputation through the mid-shaft some seventeen days after operation (Fig. 5). The vascularity seen as pits on the cut face, as in preceding specimens, is very marked. Toward the periphery this vascularity is accompanied by erosion and rounding of the margins.

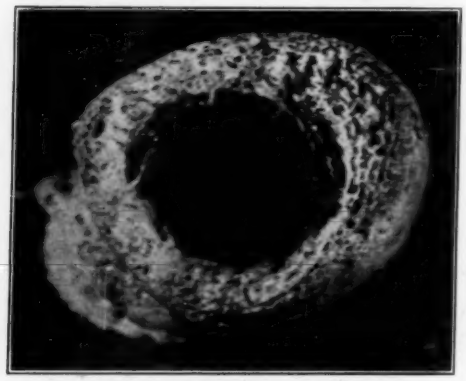

FIG. 5

Amputation right femur. W. R. U. 1585. Male, negro, age 31 years.

Amputation through mid-shaft some 17 days previously.

Note general vascularity and erosion especially of margins. The concentric thin lamellae of bone in marrow cavity may be the final transformation of cancellous tissue upon which the definitive cap is elaborated.

There is no internal callus present in the specimen. This absence or minimal development of endosteal callus is of more than ordinary interest, for surrounding the marrow cavity are several irregular concentric sheets of thin bone composed of cancellous tissue. Successive specimens suggest that this may be the final transformation of the internal callus, forming a framework upon which the definitive cap is elaborated.

There is a large mass of external callus on the posterior surface of the shaft medial to the linea aspera. It is somewhat proximal to the cut end, very porous in texture, with definite erosion of cortical bone beneath.

The vascular apertures both on the surface of the shaft and on the cut end are much larger than in previous specimens. In places they are narrowed by an exuberance of recent bone of wax-like texture. This phenomenon is more pronounced in specimens described later.

SEVERAL WEEKS

Right femur, amputated through the mid-shaft several weeks previously (Fig. 6), W. R. U. 952, was obtained from a male, white, age forty years. Erosion has rounded the outer edge of the cut face which is of much closer texture than that of the preceding specimen and indicates a further stage in the healing process.

The margin of the medullary canal is for the most part sharply angular with a tendency to curl toward the center of the marrow cavity. This is most marked at the anterior margin, where it has extended some little distance across the open end, spreading itself over the new cancellous endosteal callus as over a framework.

As in the two preceding specimens, there is a small remnant of external callus on the posterior surface of the shaft, which likewise shows a much closer texture, illustrating the approach of a quiescent period such as presents itself in the example next upon our list.

FIG. 6

Amputation right femur. W. R. U. 952. Male, white, age 40 years.

Amputation through middle of shaft several weeks previously. Outer edge of cut face eroded. Closer texture of cut face indicates a further stage in healing. Extension of endosteal callus to form partial cap.

FIG. 7

Amputation left femur. W. R. U. 1519. Male, white, age 71 years.

Old amputation through lower shaft. Fenestrated cap of condensed cancellous bone, with periosteal osteophyte of condensed texture.

ULTIMATE APPEARANCE

Left femur W. R. U. 1519, male, white, age seventy-one years, is an old amputation through the mid-shaft. The margins of the cut face are rounded (Fig. 7). The texture of the imperfect cap is even more condensed and lava-like in appearance than in the preceding specimen. The cap of endosteal callus is most nearly complete posteriorly, where its texture is also most condensed and shows greatest progress in healing. The medullary canal is indeed now more than half closed by an irregularly fenestrated cap, the inner parts of which are composed of a mere bony meshwork.

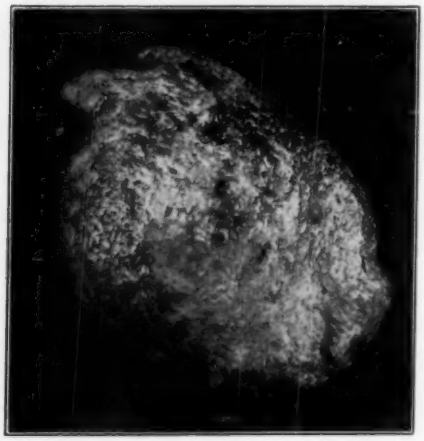

FIG. 8

Amputation right femur. W. R. U. 1217. Male, white, age 59 years.
Old amputation through upper shaft. Ideal technical result with completely quiescent though irregularly osteoporotic cap and negligible osteophytes. Note the waxy texture of the quiescent bone.

A periosteal osteophyte of condensed texture appears medial to the linea aspera in the site where external callus has been noted on three femoral amputations previously described.

The final stage seen in our specimen W. R. U. 1217, male, white, age fifty-nine years, is again an amputation of long standing through the upper shaft of the right femur. The margins of the cut face have been rounded and the marrow cavity has been completely closed by a cap, erratic in thickness, translucent in places, and everywhere composed of quiescent waxy textured bone (Fig. 8). There is lipping with some osteophytic development in the usual site, medial to the linea aspera and also on the lateral margin.

SUMMARY

In the foregoing pages we have presented specimens illustrating in detail the several stages of healing bone in amputation stumps.

Within five or six days from the date of operation (W. R. U. 262) the cut surface is rarefied by increased vascularity so fine that, though it is obvious in the roentgenogram, it cannot be seen on the specimen except under magnification. This erosion gradually obliterates the saw cuts and rounds off the margins of the cut face.

By the lapse of eleven days after operation (W. R. U. 864) the erosion, unequally progressive and still permitting evidence of the saw cuts, is plainly most active in those areas of the cut shaft which are thinnest and least injured.

After thirteen days (W. R. U. 319) the saw cuts may be entirely obliterated and callus, both periosteal and endosteal, well developed.

If the amputation has taken place through cancellous tissue and not through the marrow cavity, the lapse of fifteen days (W. R. U. 1019) is enough to permit fair healing with even the commencing appearance of waxy textured bone on the face of the stump.

But if the marrow cavity be opened, seventeen days later the canal is still quite patent, though narrowed somewhat by the development of concentric rings from the endosteal callus (W. R. U. 1585).

After several weeks the endosteal callus has formed an imperfect cap for the medullary cavity and the vascular channels on the eroded cut face are narrowed (W. R. U. 952). This is soon followed by the closure of the vascular channels and by a wax-like transformation of the texture of the new bone (W. R. U. 1519, W. R. U. 1217).

CONCLUSIONS

Early vascularity with erosion are characteristic of the first stage in bone healing after amputation. The production of periosteal and endosteal callus is minimal and definitive callus is almost lacking. Nevertheless, capping of the medullary cavity is more or less completely attained, after which the amputated face becomes quiescent. The vascular channels fill in and become obliterated by a quiescent bone of waxy texture. The after-results of amputation are therefore precisely similar in kind though not in degree to those seen after fracture.

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THE EFFECT OF IRRADIATED ERGOSTEROL ON THE HEALING OF EXPERIMENTALLY PRODUCED FRACTURES IN ANIMALS*

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Irradiated ergosterol has been widely used in the last two years, chiefly in the treatment of rickets. It also has been shown to have a healing action in osteomalacia and allied diseases of disturbed metabolism of bone. In the experiments of the author the irradiated ergosterol was given by mouth, and the effect on the healing of experimentally produced fractures of long bones was observed. It was hoped that information might be obtained which would be useful in the treatment of clinical cases of ununited fractures, the treatment of which has not been generally satisfactory.

Fractures were produced in the tibiae and fibulae of rabbits and in the fibulae of rats. The rabbits were adult animals, averaging in weight two and eight one-hundredths kilograms, and the rats were large white males. Ether anaesthesia was used in all operations. In the first series (thirty rabbits), a fracture of the tibia was produced manually and the leg was splinted with a combined wood-and-plaster splint, immobilizing the knee joint and the ankle joint. In the second series (ten rabbits), the fibulae were fractured by open osteotomy and the tissues were closed in the usual aseptic manner. Plaster casts were not used, since immobilization was produced by the sound tibia. In rabbits the fibula is firmly connected by ligaments to the proximal end of the tibia and is fused to the middle third of the tibia at its distal end. The mortality in both series was high, because of intercurrent disease. In the third series (twenty rats), open osteotomy of the fibula was done; all of these animals lived. They hopped around on their fractured legs as soon as they recovered from the anaesthesia. The plaster casts did not seem to impair their locomotion or general health. Those that died generally died before the seventh day, in many instances from pneumonia. Roentgenograms were taken through the plaster, which was not removed until the animals were killed. Infection did not occur in the wounds which were covered only by collodion dressings.

The living conditions and diet were those usually provided for laboratory animals. The rabbits received an abundance of oats and hay, and regular feeding with turnips, mangel-wurzels, and so forth. The rats received a balanced ration, known as the Wisconsin ration, containing:

*Work done in the Division of Experimental Surgery and Pathology.

Yellow corn meal	69.00 per cent.
Linseed oil meal	14.60 per cent.
Ground alfalfa	1.90 per cent.
Crude casein	4.60 per cent.
Sodium chloride	0.45 per cent.
Calcium carbonate	0.45 per cent.
Powdered skim milk	9.00 per cent.

It was considered that these diets contained a sufficient amount of the necessary food factors and vitamins for the growth and nutrition of the animals. Irradiated ergosterol in the form of one milligram to one cubic centimeter of linseed oil was given to the rabbits by means of a medicine dropper in doses of three milligrams daily. Higher dosage was tried but was not well tolerated; several of the animals died apparently from the toxicity of the drug. The oil containing ergosterol was mixed with the food of the rats and the amounts were measured. The rats received on an average one and twenty-five one-hundredths milligrams of the ergosterol each day. An equal number of animals were used as controls. Roentgenograms of the fractures of the rabbits were taken at eight-day intervals, and of the rats at five-day intervals. One animal used as a control and one used as a test of each series were killed by bleeding under ether at five, ten, fifteen, twenty, twenty-five, and thirty days after the operation. Sections of bone were removed, decalcified, cut through the center in a longitudinal direction, and stained with hematoxylin and eosin.

New bone cells were first noted on the fourth day. This was in a treated rabbit which died of pneumonia. The osteoid cells were seen at the edge of the old bone as cells with dark blue nuclei and pinkish staining cytoplasm. This tissue was very cellular. Not until several days later was there definite evidence of cartilage cells. At the seventh day in one section cartilage cells were seen. Definite evidence of trabecular formation first appeared at the fifth day in a treated animal. Sections taken from animals killed at later dates contained varying amounts of cartilage, osteoid cells, and trabeculae of new bone. There seemed to be no difference between the appearance of the bone of the treated animals and that of the control animals. As the time of healing increased, the amount of trabecular formation became larger. The first solid union demonstrable grossly and microscopically was evident at the twenty-first day in a control animal. Fibrous union only had been obtained at the sixteenth and eighteenth days. In bone that was united solidly, the space between the ends of bone was filled with closely interlacing trabeculae of new bone. It was easily distinguished from the old bone by reason of its increased cellularity. Two animals were allowed to live for sixty days before they were killed. In these, the trabeculae between the ends of the bone were beginning to show absorption in its central part, preparatory to the formation of new marrow. Here also there was no difference between the treated animals and the control animals. This was the same in the three series.

It seemed to be of great significance that the ends of the bone should be in good apposition. This was easy to procure in the fibulae of rabbits and rats, but was not always procured in the tibiae. In some fractures of the tibia, where alignment was poor and there was more or less separation, union did not occur for thirty-five to forty days, and sometimes not then. Only animals in which alignment was good are considered in this report.

The roentgenograms of the tibiae did not show evidence of the formation of bone until the sixteenth day, and from this time on callus was evident. The roentgenograms were deceptive in some instances; what appeared to be light callus was in reality that of solid union. In the fibulae of rabbits, the roentgenograms showed some formation of callus in ten days, more of them showed it in twenty days, and invariably, solid union was present in thirty days. In some of the rats, shadow of callus was present at ten days; at fifteen days it was invariably present, and from then on it became more and more dense. Here, also, the roentgenograms of the fracture could not be relied on implicitly, because what appeared to be solid union was found on postmortem examination to be fibrous union. In other cases in which the roentgenograms did not show union, the fracture was found to be united at necropsy.

In an attempt to learn whether calcification was produced in any of the soft tissues, the aortae of the treated and untreated animals were sectioned and stained with a silver-nitrate stain to show calcification. In no case was calcification found in the wall of the aorta of a normal animal. However, in eight (fifteen per cent.) of fifty-two of the treated animals calcification was found to a greater or less degree. This was apparent by the deposits of black-staining homogeneous material in the media of the vessels. This varied in degree from small black flecks to heavy opaque masses. In two animals there were areas of calcification visible in the walls of the stomach and intestines, in the substance of the kidney and liver, and in the valves of the heart. These areas were stained, and heavy deposits of calcium were found.

From these results it seems clear that irradiated ergosterol given by mouth does not have a demonstrable effect on the rate of ossification or the amount of callus in fractures of normal animals. Probably, if the metabolism of the animals had been rendered abnormal by the exclusion of a certain vitamin or vitamins, there would have been a difference after the administration of ergosterol. The metabolism of the bone approximated normal. An attempt was not made to simulate the conditions present in cases of non-union of fractures in man. These factors are not definitely known and the problem of reproduction of non-union of fractures in animals would have to be solved before the ergosterol could be used. The one significant factor in the rate of healing of the fractures seemed to be the state of the alignment of the ends of bone. Angulation and lack of contact lengthened the time of union. The rate of formation and the amount of callus seemed to be almost directly proportional to the degree of good apposition of the ends of the fractured bone.

The production of calcification in the soft tissues is not of significance. Calcification in the aortae of rabbits is sometimes found normally, and apparently occurs more commonly after the feeding of cholesterol and other substances. The finding of calcification in several organs—such as the heart, liver, kidney, and stomach— of the same animal is suggestive that this was produced by the ergosterol, but as this was found only once in the three series of animals, it is not of great significance.

Ergosterol is a sterol similar to cholesterol. It contains three unsaturated carbon linkages, an hydroxyl radical, and probably four carbocyclic groupings. It is precipitated by digitonin, is somewhat unstable to oxidation, and is of no value antirachitically. It has characteristic absorption bands at 293.5, 281.5, and 270 millimicrons. Irradiation with ultraviolet rays shorter than 313 millimicrons in wave length converts ergosterol into vitamin D. This substance is not precipitated by digitonin, it is more stable to oxidation, and shows an absorption band with a maximum at 247 millimicrons. It has a favorable influence on the metabolism of calcium. Irradiation for long periods of time destroys the vitamin D power of the ergosterol, and the absorption band at 247 millimicrons disappears.

Ergosterol was first isolated by Tanret in 1888. Windaus and Hess, and Rosenheim and Webster, found that irradiated cholesterol was antirachitic but that purified cholesterol, irradiated, was not antirachitic, and concluded that the contaminating substance was ergosterol. They, and others, have since proved this to be true.

Hottinger and Holtz, and Roussel and Guilbron cured experimental rickets in rats and dogs by giving irradiated ergosterol. Other experimenters secured similar results. Ergosterol is usually given with milk in the treatment of rickets in children. Vollmer, experimenting with rats, found that parenteral administration was effective but that larger doses were required. György, Mouzon, Hess and Lewis, Karelitz, Wurzinger, Wiedow, Wilkes, Follett and Marples, and many others, have reported favorable results with irradiated ergosterol in the treatment of rickets in children.

Brougher prevented tetany in thyroparathyroidectomized dogs with irradiated ergosterol. Urechia and Popoviciu were not able to confirm this. Bakwin, Bakwin and Gottschall, and Gleich and Goodman reported curative results from the drug in infantile tetany. Stern reported cure with irradiated ergosterol in six weeks in a case of tetany following thyroidectomy, in which there had been symptoms for fifteen years. Starlinger and Goldstein reported cures in osteomalacia with ergosterol. Tammann prevented loss of weight and osteoporosis in osteomalacia following the action of biliary fistulae in dogs. Seyderhelm and Tammann prevented anaemia in dogs with biliary fistulae, thus showing the action of irradiated ergosterol on the blood regenerative organs. Pattison reported slight improvement in tuberculosis of the bone in children, and Moro stated that the appetite of children with tuberculosis of the bone was greatly stimu-

lated. Mellanby and Pattison prevented the occurrence and spread of caries in the teeth of children by the use of irradiated ergosterol. Ertl and Hain gave it to women who were pregnant and to anaemic women with loss of appetite; it improved the condition of the blood and also the appetite. Walther gave it effectively to women who had secondary anaemia from irregular menstruation and excessive loss of blood. Rosenow, in three cases of pernicious anaemia in which benefit was not derived from a diet which included liver, added irradiated ergosterol and observed improvement in the anaemia. Perutz and Rosner used it successfully in cases of syphilis in which the Wassermann reaction of the blood was positive, in syphilitic osteoperiostitis, and in syphilitic ulcers which refused to heal under the usual antisyphilitic treatment. Eising reported improvement in the general health of a patient with Parkinson's disease who used the drug. Bond used it successfully as a dressing for wounds. Feriz used it in his surgical practice to raise the calcium content of the blood, to stabilize the tonus of organs, and to protect against shock. Eichholz and Kreitmair expressed the belief that it increases the immunity against pathogenic micro-organisms. Kroetz found that men who were given large doses of the drug (two receiving eighteen milligrams daily and two others thirty milligrams daily for seven to eight days) showed increased alveolar carbon-dioxide combining power, increased alkali reserve, and increased inorganic phosphorus of the blood; the serum phosphorus was diminished slightly.

Reyher and Walkhoff produced calcification in the heart, kidneys, and other organs of guinea pigs by giving massive doses of irradiated ergosterol. Kreitmair and Moll gave ten to twenty milligrams daily to rats, mice, rabbits, and guinea pigs; the animals lost weight, became ill, and died. Harris and Moore did similar work. Dixon and Hoyle found that five to ten milligrams daily produced urinary concretions. Heubner found thickening of the media, and hyalinization and calcification in the arteries of the kidneys. Klein produced loss of weight and retardation of growth in rats, and found that the serum calcium was fifty per cent. higher than normal. Pfannenstiel, Rabl, Smith and Elvove, Mancke, Wenzel, and Kreitmair and Hintzelmann all produced toxic effects on laboratory animals.

Bamberger and Spranger reported injurious effects in the kidneys of patients with tuberculosis; they found erythrocytes, casts, and albumin in the urine. In a later report, Bamberger stated that he believed these results to be due not to hypervitaminosis but rather to contamination or degeneration of the ergosterol.

Selye reported that irradiated ergosterol shortened the coagulation time of blood, the effect being increased by the concomitant use of calcium. Handovsky, by giving irradiated ergosterol, raised the cholesterol content of the blood and changed the carbohydrate content of muscles, as well as the cholesterol content of muscles and liver. Hess, Weinstock, and Rivkin fed young rats a diet free from calcium, thus lowering the calcium of the blood. The administration of irradiated ergosterol raised the calcium

of the blood more than fifty per cent. The calcium must have been derived from the tissues.

Bors fractured the fibulae of rabbits and gave one milligram of irradiated ergosterol daily for twenty-two days. Roentgenograms were made at four-day intervals. Up to the twelfth day there was no difference in the roentgenographic appearance in the treated and the untreated animals. In from twelve to fifteen days the callus in the treated animals became more dense. In from fifteen to twenty-two days it grew more rapidly and consolidated. At twenty-two days the callus in the treated animals was much denser than in the control animals.

Hellner used one milligram of irradiated ergosterol daily, and found that there was no increase in the formation of callus, no difference in healing, histologically, and no difference in the calcium content of the bone, chemically. He fractured the tibia and fibula manually.

Vara-Lopez sawed through the ulna of guinea pigs and fixed the ends of the bone in apposition by suturing the muscle so that movement was not possible. He gave the animals four cubic centimeters of irradiated ergosterol in oil, suspended in milk, daily, and took roentgenograms at four-day intervals for twenty-five days. The rate of healing and the amount of callus formed were not increased. The bones did not move so that perfect apposition was maintained. Histologic study of the bone did not show changes or differences. Animals of similar weight and size were used, and they received the same diet except for the ergosterol.

In a clinical study of fifty-one fractures of long bones, Knoflach gave irradiated ergosterol in doses of five to ten milligrams daily and noted an increase in the amount and density of the callus as compared with that in the controls. This increase began in the third week of the fracture and was particularly great in elderly persons and children. In patients aged more than fifty-five years, the time required for bony union was distinctly shortened, but in other patients, at other periods of life, difference in this respect was not significant. He also gave calcium phosphate by mouth and used hyperaemia in treatment.

CONCLUSIONS

1. Irradiated ergosterol given by mouth to rabbits, in doses of three milligrams daily, did not increase the rate of healing or the amount of callus formed in fractures of the tibia and fibula.

2. Irradiated ergosterol given to rats with the food, in doses of one and twenty-five one-hundredths milligrams daily, did not increase the rate of healing or amount of callus formed in fractures of the fibula.

3. There is some evidence that the administration of irradiated ergosterol to animals by mouth will produce calcification in blood vessels and other soft tissues.

4. The most significant factor in the rate of healing and in the union of experimental fractures in animals is the degree of apposition of the fragments of bone.

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ON THE IMPORTANCE OF CAUTIOUS PROGNOSIS IN ORTHOPAEDIC CASES*

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While patients invariably seek to learn their physician's prognosis, the treatment is generally little affected thereby, whether the prognosis is good, bad, or hidden under a barrage of "ifs" and "providings". The doctor's reputation may be enhanced by a correct forecasting of events, but his skill in diagnosis and treatment is the measure of his success. In orthopaedic surgery, however, the treatment must depend to a great extent upon the prognosis; therefore it assumes a highly important position. In one case a certain line of treatment may render the best possible results, while in another similar case it would prove unsatisfactory. Were it only a matter of changing a prescription after a few days' trial, it would be of little consequence; but it is more likely to be a matter of pursuing a course which cannot be retraced or involving much time and expense with psychological effects upon the patient and relatives.

To illustrate: A case of tuberculous disease of the knee in its early stages presents itself. An immediate operation is pretty sure to eradicate the disease in eight or ten months, but it leaves the knee absent of all function other than that of support. Conservative treatment, if painstakingly carried out, offers a possibility of a cure in two years, with knee function normal or nearly so. But, accepting these two statements as true, the prognosis cannot rest upon them solely. In this particular case, is the disease limited practically to the knee or is the patient of a tuberculous diathesis? Will operation eradicate the disease? Will conservative treatment be carried out or will the patient have proper care only intermittently? Will conservative treatment control the disease only to the extent of making the constant wearing of some apparatus necessary? How valuable in this case would be a trustworthy prognosis!

Enthusiasm is the best incentive to explorers, discoverers, and inventors. It is a characteristic of men with vision and imagination, but allowance must be made for its white heat and its contraction following cooling to normal temperature. Illustrating this, let me cite the case of a boy, fourteen years old, brought to me in the hope that something could be done to decrease the deformity of his spine. When four years of age, while apparently in excellent health, a diagnosis of Pott's disease had been made. Immediate operation was advised as a saving of a long period of conservative treatment and a certain cure, with little or no deformity. The patient was operated upon and then treated on a frame for three years and wore a

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brace for the following four years. The x-ray now shows marked destruction of bone, but the spine is evidently free of any disease and the deformity not more, perhaps less, than might be expected. The prognosis was wrong. The operation is a valuable one but did not, in this case, arrest the disease, shorten the time of treatment, or avoid a deformity, in accordance with the prognostication.

Then again, I can cite a case of dorsal Pott's disease, correctly diagnosed at the age of fourteen; the patient received conservative treatment but the deformity increased to such an extent before the disease was arrested that a spinal operation would have been of distinct advantage.

Another illuminating case is one of dorsal-lumbar Pott's disease in a girl of eight, who was treated conservatively and has but little deformity and no restriction of movement below the second lumbar.

The prognosis in the case of a tuberculous joint, if the patient is under ten years of age, is in excellent health otherwise, lives in a suitable environment with the assurance of cooperation in every detail of treatment, and whose joint does not show in the x-ray marked destruction of bone, is excellent for a cure of the disease with only slightly impaired function. With partial destruction of the joint but with other conditions the same, the prognosis of a cure is excellent but the usefulness of the joint must depend on changes in the joint structures. Prognosis as to range of movements is extremely difficult as the x-ray pictures may give an entirely erroneous impression. If prognosis is sought after the disease has been allowed to progress, either through lack of treatment or through intermittent treatment or treatment illy planned, it had better be withheld until after two months of observation under approved treatment.

Operation in cases under ten years of age affects the prognosis but slightly unless effectual treatment cannot be carried out. Then it improves the prognosis. After ten years of age the prognosis is changed by many factors. The difficulties in the way of carrying out uninterrupted prolonged treatment multiply with the years and, furthermore, the older the patient the more amenable are the joint structures to operation.

A woman consulted me for a painful back. It was very painful and had been so for several months. There was a history of having been thrown from a horse; also a previous similar injury ten years before. Radiographs showed a pronounced pathology of the lower spine. Consultation with another surgeon had offered her a probable cure by operation, but absolutely the life of an invalid without one. Treatment of the case as traumatism to an old healed lesion resulted in a cure, with the patient's resumption of riding and all other activities.

Prognosing in spinal injuries calls for a correct interpretation of the relation of the symptoms following the traumatism to the condition revealed by the x-rays, which is often times difficult. Abnormalities and old healed injuries may not have been factors in the recent disturbance other than rendering the part more vulnerable than it otherwise would have been. In such a case, the prognosis will rest upon the restoration of the spine to its

condition previous to injury. If there is a sacralization of the last lumbar, a tendency to spondylolisthesis, or the impingement of a process on another bone, or if the relation of the fragments of an old fracture has been disturbed, the prognosis will depend on treatment of that preexisting condition.

Prognosis of a spinal curvature is difficult and most important. Will the deformity increase with treatment or can it be corrected with treatment? Will an operation stop the formation of an ugly deformity? There are curvatures which are easily corrected; others which can be cured with careful, prolonged treatment; and still others which no treatment except operation will arrest. A very grave responsibility rests upon the prognosticator. One should be able to prognose whether the correction obtainable at the time of consultation can be held by changing the position of the plane containing the center of gravity, by the support of a brace, by increasing muscular power, or by operation, especially in cases of poliomyelitis.

In poliomyelitis the prognosis must determine the treatment for loss of function after the infection is arrested. If one could determine exactly just which spinal cells are beyond repair, the job would be easier. Many a muscle which has suffered from the original paralysis remains functionless after recovery of its spinal cell, from prolonged non-use, stretching and loss of other muscles coordinating with it. So frequently is a hopeful prognosis given, based usually on careless observations, that literally thousands of cases are wasting time and effort with electricity, massage, hydrotherapy, and muscle training. No treatment of a muscle can make it function if its enervation is not restored. A small muscle with its nerves intact may be trained to do double its normal duty; but to hope that it will develop to do quadruple the work it was intended to do is nonsense.

Hydrotherapy, such as voluntary movements while the patient is in a bath, especially one of high specific gravity, increases muscular strength; but many patients are subjected to this treatment over a long period of time where a correct prognosis would point to the utter impossibility of useful function ever being restored and the inutility of the treatment except for the transitory feeling of exhilaration which the patient usually experiences.

In poliomyelitis, prognosis is impossible during the first year. Improvement can be recognized and pointed out for encouragement, but foretelling results is beyond us. Probably no affected cord cell recovers after a year has elapsed. Neither can a safe prognosis be given in a neglected case where deformities exist or where muscles have been allowed to suffer strain, until after the correction of deformities, protection of muscles by retention in the neutral position, and three months of mechanotherapy, thrice weekly. Approval of a line of treatment because "at any rate it can do no harm" should be beneath one's dignity, unless it assists to obtain the patient's cooperation in some other respect, just as it may be advisable at times to prescribe a bottle of spring water when faucet water would be as beneficial. We should not prescribe physical aids except when the prognosis is improved thereby. Treatment by physiotherapy of muscles whose

cord centers are destroyed does not improve the prognosis, nor does such treatment of muscles whose restoration to function under the surrounding circumstances is practically useless. The anxiety to "do something" is responsible for the quite general indiscriminate use of light rays, electricity, massage, and water.

The patient or his guardians should not be hurried into a decision as to the nature of treatment. The advantages and disadvantages should be made clear. An eminent English surgeon told me that he had had many patients, for whom he had done an arthrodesis of the knee for paralysis, return and beg to have the knee restored to its former movable condition, which they would prefer even though a brace were necessary. On the other hand, many a patient is struggling through life with a cumbersome brace, which is often a financial burden as well, who would be much better off with eradication of the joint.

In making any prognosis, one should consider not only the cure of disease, the correction of deformity, and the restoration of function, but also the effect of treatment upon the general health, physical and mental, and upon other functions which may have to be impaired or sacrificed.

Naturally a man selects the tools with which he is most expert. To be broad-minded one must be skilled in all therapeutic measures; and such measures of value to the orthopaedic surgeon are found in the Operating Room, the Drug Room, the Machine Shop, and the Physiotherapy Department. Expert use of all of these measures can come only through years of experience,—and with this experience must come the skill to prognosticate.

PATHOGENESIS OF CONGENITAL CLUB-FOOT (Pes Equinovarus)

An Anatomical Study*

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Any discussion of congenital anomalies from the standpoint of etiology and pathology is inevitably beset with numerous difficulties which must be explained in a satisfactory manner before a conception of the true nature of the condition can be formed. The reasons for this are in some measure apparent. As such defects usually have their origin during a very early period of intra-uterine life, we are handicapped by the lack of proper access to the involved structures at the time when maldevelopment has its beginning. In attempting to determine the process of malformation, we must be guided by the processes as they are normally seen; and by investigation of the pathological features, interpret the mechanism by which deviation from the normal course of development takes place. Defects vary within wide limits, and for this reason, an enormous number of theories have arisen to account for situations which developmentally may be identical, and yet in degree may differ widely. The numerous and diverse conceptions of even so very common an anomaly as club-foot are witness to the fact that there is an incomplete understanding of this abnormality; and in view of its frequency of occurrence, it seems that no serious attempt has been made to solve the difficulties, which, from a close consideration of the many views offered as an explanation, must undoubtedly be of a more far-reaching nature than they appear to be from a superficial inspection.

As in all pathological conditions, the main feature is the treatment, and this has unquestionably progressed in recent years with the development of surgical measures, successfully applied to correct practically any type of foot deformity. While it is possible to secure such correction and restoration of function by operative means, it is essential that we should have also a thorough knowledge of the basic factors underlying the conditions with which we are dealing. There is very little doubt but that our therapy can be more successfully planned and executed with such knowledge available.

As congenital club-foot is only one of a large group of congenital anomalies and as, etiologically, it embraces a number of features common to other forms, it seems pertinent to mention briefly the more generally discussed problems of this large group. In this respect we have first to consider the theories utilized to explain all or some defects of congenital origin as the result of mechanical influences.

As exogenous factors acting during the intra-uterine period and having a possible relation to congenital abnormalities, Aschner and Engelmann enumerate the following: (1) pressure of the wall of the uterus; (2) active

*From the Pathological Laboratory of St. Francis' Hospital.

contraction of the uterus; (3) general narrowness of the amnion; (4) amniotic adhesions as result of inflammation; (5) amniotic constriction; (6) constrictions by umbilicus; (7) compression between umbilicus and amnion; (8) extra-uterine pregnancy; (9) uterine tumors; (10) multiple pregnancy; (11) narrowing due to pelvic tumors; (12) infectious diseases of the mother.

It is pointed out by these writers that the time relations between cause and effect are very inconsistent; that such mechanical agencies are in most instances active in the later periods of pregnancy, whereas the beginning of the defect is placed at an early period of foetal life. The occasional occurrence in such manner is not contradicted, however, and it is evident that certain abnormalities are very clearly due to such processes.

HEREDITY IN CONGENITAL ANOMALIES

The influence of heredity in congenital anomalies is so pronounced that its importance cannot be successfully disputed. In order to understand properly the part played by inheritance, a knowledge of the laws of heredity is very essential. In this respect the principles of Mendel are utilized to account for the transmission of characteristics and peculiarities, and while the different features of the Mendelian law have been studied almost exclusively in plants and lower forms of animal life, it is also successfully applied to interpret the process of inheritance in man. This is shown by the work of Aschner and Engelmann who, following the teachings of Julius Bauer, have studied the constitutional aspects of orthopaedic deformities, and have pointed out that inheritance in man proceeds along lines similar to those observed in plants and lower animals.

Starting with the basic principle that all characteristics and peculiarities are transmitted to succeeding generations by a group of hereditary factors called genes or ids, and proceeding further with the generally accepted idea that these genes are contained in the chromosomes of the germ-cell nucleus, these writers have emphasized the hereditary nature of certain deformities, and have in a large measure demonstrated the biogenetic relations, as interpreted from an intensive study of family pedigrees. Thus they were able to predicate the existence of genes or gene complexes for the normal number of organs, the pathological alteration of which caused multiple formations; genes for the development of individual portions of organs, whose pathological allelomorphs lead to defective formation. In addition there are genes which control the normal segmentation of fingers, the normal ossification of bones, the normal approximation of joint surfaces, the normal range of joint motion, and the normal number and development of muscles. "Disturbances within these genes subserving the topographic construction of the organism bring about a diminished resistance, a biological inferiority of the particular portion, upon which different exogenous and endogenous factors can easily act."

With reference to the hereditary nature of club-foot Aschner and Engelmann state, "With certainty it may be said only that a hereditary trait

exists in congenital club-foot which becomes manifest about twice as frequently in men as in women, which has a recessive, possibly polygenous hereditary course, and in some manner influences the sex ratio in favor of the males". Following a discussion of the relationship between congenital club-foot and spina bifida occulta, these writers continue, "Whatever is inherited is therefore not a spina bifida and myelodysplasia, but undoubtedly the abnormal position of the foot".

When we consider the importance of heredity and appreciate the lack of definite and complete knowledge of the pathological features which are directly responsible for the occurrence and the development of this anomaly, we must be impressed with the necessity for further investigation in that direction. As it is a disturbance of early embryonic life, it is imperative that we know accurately the structures which are first to be affected in the genesis of club-foot. There seems, of course, to be very little doubt but that, ultimately, congenital club-foot has a constitutional basis; that the factor which is responsible originally is present in the germ cells of one of the parents, in the biological sense.

Applying the principle of gene control to the development of club-foot, it may seem sufficient to state that the structure and the form of the foot are genetically dependent on certain hereditary factors in the chromosomes of the parental cells, yet that would hardly account for the development of congenital pes equinovarus more frequently than other types of congenital anomalies of the foot. Thus it seems that while individual genes may be responsible for the form, position, and structure of each individual component of the foot, it leaves us without any reason why one kind of deformity should be more common than any other kind. Since study of inheritance of club-foot has revealed no accurate knowledge of the gene or gene complex which is disturbed, and as such knowledge is highly desirable in solving the genetic problems of this deformity, it seems necessary for a proper interpretation of the developmental features to make a study of the pathological peculiarities.

It is comparatively easy to understand why geneticists are unable to interpret the mechanism of heredity properly and completely. Their studies are directed toward a determination of gene function in all cases in which heredity is discernible. In a condition like congenital club-foot there are, as stated, a number of conflicting theories in regard to the pathogenesis, each theory having a certain amount of inconclusive evidence to support it, and no one theory being sufficiently substantiated to be looked upon as being flawless. While there are no doubt certain instances in which the pathological features are entirely clear, the large majority of cases of typical congenital club-foot present difficulties, which seem to be brought about by extensive physiological disturbances, and it is the object of this study to determine by anatomical investigations the manner in which such physiological alterations may be produced.

No attempt will be made here to discuss the anatomy of the foot proper. The structural relations have been accurately described many times, and

repetition is superfluous. Moreover, it is felt that the position and the form of the various components of the foot are secondary to changes in the soft tissues which control them, and on this basis it is undoubtedly much more important to consider the disturbances which are primarily responsible for the deformity. In this respect the observations relative to neuromuscular involvement in club-foot stand out most conspicuously.

The material available for examination is unfortunately limited, consisting of only one specimen.

The obstetrical report obtained from Dr. E. B. Ross indicated that pregnancy and labor were in all respects normal, except that delivery was about six weeks premature. This was the first pregnancy of the mother. The child lived for about half an hour after delivery, which occurred March 23, 1929. Close questioning of the parents did not reveal any history of abnormalities among the relatives.

The general autopsy report by Dr. C. Alexander Hellwig, pathologist at St. Francis' Hospital, was as follows:

> The body was that of a new-born baby, premature at about the eighth month of pregnancy. The measurement from head to coccyx was twenty-five and seven-tenths centimeters. Rigor mortis was not present. The upper extremities were normal and the lower extremities showed a bilateral club-foot. The head was well formed and showed no anomalies of the eyes, ears, or mouth. The heart was normal. The upper lobes of the lungs were atelectatic and contained no air. The thymus was very large.
>
> The large intestine opened into an extrophic urinary bladder. A Meckel's diverticulum about three centimeters long was found in the typical location. The spleen was normal in size; the liver was very large. The adrenals were larger than normal and both kidneys were cystic. Both testicles were undescended and the halves of the scrotum were not united.
>
> Following the autopsy, the specimen was placed in formalin and dissection was commenced several months later.
>
> The following measurements were obtained and represent the circumference in millimeters:

Left arm	88
Right arm	88
Left forearm	87
Right forearm	87
Left thigh	108
Right thigh	114
Left leg	81
Right leg	91

The roentgenographic examination (Fig. 1) showed a number of defective vertebrae in the dorsal and lumbar regions. In the dorsal region the bodies of several vertebrae were incomplete. In the lumbar region the pedicles were absent on the left.

In the lower extremities both feet were in the position of equinovarus (Fig. 2). On the right the whole foot was involved, whereas on the left the position was more one of adduction of the forefoot in addition to the equinus deformity. The right leg and foot showed a dark discoloration which was not present on the left.

The muscle tissues were exposed by reflecting the skin and the subcutaneous tissues. On the right side the subcutaneous tissues contained a moderate amount of clear serous fluid. The muscles showed a striking difference in color between the two sides (Fig. 3). On the left the muscles were pale and similar in color to those of the back and the right forearm. The muscles of the right leg showed a rather uniform discoloration which was

most marked in the peronei, the tibialis anterior, extensor digitorum longus and extensor hallucis. The discoloration involved also the posterior muscles of the leg and the quadriceps extensor, but here it was not so pronounced as in the anterior muscles of the leg.

The nerves of the lower extremities showed differences in color and in size. On both sides, the cutaneous portions of the superficial peroneal nerves appeared normal in size

FIG. 1

Roentgenogram of specimen.

FIG. 2

Photograph of specimen. Note position of feet and discoloration in right leg and foot.

FIG. 3

Photograph to illustrate difference in color of leg muscles on the two sides. Compare with muscles of right forearm.

and color. The tibial and peroneal nerves on the right were noticeably smaller than those on the left; they also showed a discoloration which was not present on the left. The color was a brownish red, and had very much the appearance of an old hemorrhage. The same color difference was noted in the deep peroneal nerves.

The spine, on external examination, appeared normal as far as the lumbosacral junction, where a wide cleft could be palpated. This extended throughout the length of the sacrum posteriorly. Through the abdomen, however, the anterior wall of the sacrum could be palpated throughout its entire extent. The skin over the cleft was freely movable and showed no external abnormalities as retraction, scars, hypertrichosis or nevus. After reflecting the skin and subcutaneous tissues of the lumbar region, a defect was found in the laminal arches of the right side, and involving the third, fourth, and fifth lumbar vertebrae. Over the sacrum posteriorly, the subcutaneous tissues were thicker and denser than they were in the lumbar region. When the cleft was reached it was found that the meninges were firmly attached to the fatty and fibrous subcutaneous mass (Fig. 4.). This attachment commenced at the lumbosacral junction and extended over the upper three sacral segments. There was no protrusion of the meninges through the cleft. The upper border of the cleft corresponded to the lower border of the fifth lumbar vertebra and consisted of very dense smooth fibrocartilaginous tissue. There were no attachments between the meninges and the upper border of the cleft. In dissecting the lower portion of the sacrum, the dural sac was opened (Fig. 4) and was found to contain a dark, chocolate-colored and friable tissue which was undoubtedly the remains of an old hemorrhage.

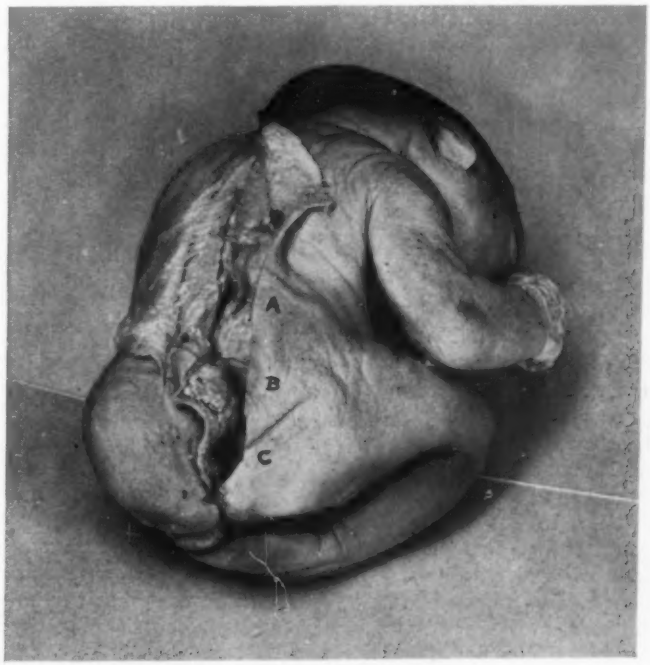

FIG. 4

Photograph of back showing opposite *A* a defect of the laminal arches of the lower lumbar vertebrae. At *B* is a sacral cleft and the dura may be seen, attached to the subcutaneous tissues. At *C* the meninges were incised and were found to contain hemorrhagic material.

After removing the laminae from the lumbar vertebrae, the spinal cord was exposed by cutting the meninges lengthwise. The dura mater and the pia-arachnoid were everywhere in close contact to each other, except at the upper sacral region on the left, where the two were separated, due evidently to the firm attachment of the dura to the subcutaneous tissues (Fig. 5). The spinal cord, instead of presenting the lumbar enlargement and giving origin to the cauda equina in the lumbar region, was found to extend distally, approximately to the level of the second sacral segment, where it bifurcated, each portion continuing for a short distance and ending in the hemorrhagic area at the lower end of the sacral canal (Fig. 5). The terminal portions of the two branches of the cord were hemorrhagic and apparently necrotic.

The nerve roots presented a peculiar arrangement in regard to the manner in which they pursued their course to reach their exits through the spinal foramina. In the middle lumbar region they had a course approximately at right angles to the cord. In the lower lumbar region they were directed obliquely upwards (Fig. 6). In addition, on the right side between the dura and the pia-arachnoid, were found three nerve roots which had a course almost parallel to the spinal cord, and extending from the pia-arachnoid at the level of the second sacral segment, upward to join the nerve roots of the fourth and fifth lumbar nerves as they left the spinal canal. This feature was not noted on the left. Here, although most of the roots also had an oblique course upwards, it was not exaggerated as on the right.

MICROSCOPIC EXAMINATION OF MUSCLES

The microscopic appearance of certain muscles of the legs was studied chiefly with the hematoxylin-eosin method. As some muscles showed variable degrees of fibrosis, the van Gieson stain was employed to determine the amount of connective tissue. An attempt was also made to determine the condition of the nervous elements in the muscles by means of the Bielschowsky-Maresch method. However, in all the sections there were so many fine connective-tissue strands that the nerve fibers were very much obscured and no accurate information could be obtained. Sections were also made of the extensor carpi ulnaris to serve as controls.

Gastrocnemius — left. The fasciculi showed a normal arrangement. There was a general narrowing of the muscle fibers and many showed a partial loss of sarcoplasm. A fine waviness was seen in some portions. Cross-striations were present in practically all fibers, but in many they were very indistinct. The muscle nuclei were enlarged in some of the fibers, but a few showed diminution in size and increased density. In the van Gieson stain a small area of fibrosis was found.

Tibialis posterior — left. This muscle showed a rather sharp line of division between two areas, one of which was normal in appearance, the other was distinctly pathological. The latter consisted of a number of small fasciculi, the fibers showing a coarse waviness and a lighter staining reaction due to loss of variable amounts of sarcoplasm in the individual fibers. There was an increase in the number of nuclei, giving the area a bluish appearance. Narrowing of the fibers was not very marked and cross-striations were present in practically all fibers, although in many they were indistinct. Loss of sarcoplasm was variable, in some fibers so pronounced that only the sarcolemma was left, which contained groups of nuclei, showing a very intense staining reaction (Fig. 7).

Extensor digitorum longus — left. The majority of the fibers were narrowed. Most of them retained their striations, but varying degrees of disintegration were noted. Some fibers showed fragmentation and loss of sarcoplasm, so that nothing was left except a few sarcolemmal fibers and groups of nuclei having a dense stain. A few fibers were found which were increased in size, having about twice the normal width.

Tibialis anterior — left. There was a marked increase in the number of muscle nuclei. These nuclei stained deeply and a large number of them were pyknotic. The fibers stained well, but showed indistinct cross-striations. A fine waviness was present in many fibers. At times whole fasciculi showed loss of sarcoplasm, degeneration being complete except for groups of pyknotic nuclei.

FIG. 5

Photograph of lumbosacral region showing the appearance and the position of the spinal cord. The bifurcation of the cord was at the level of the second sacral segment.

FIG. 6

Photograph of back showing the course of the nerve roots. The dura is retracted laterally and the pia-arachnoid medially. Note the low origin of two large nerve roots. In this illustration the course of these two roots is somewhat altered, due to retraction.

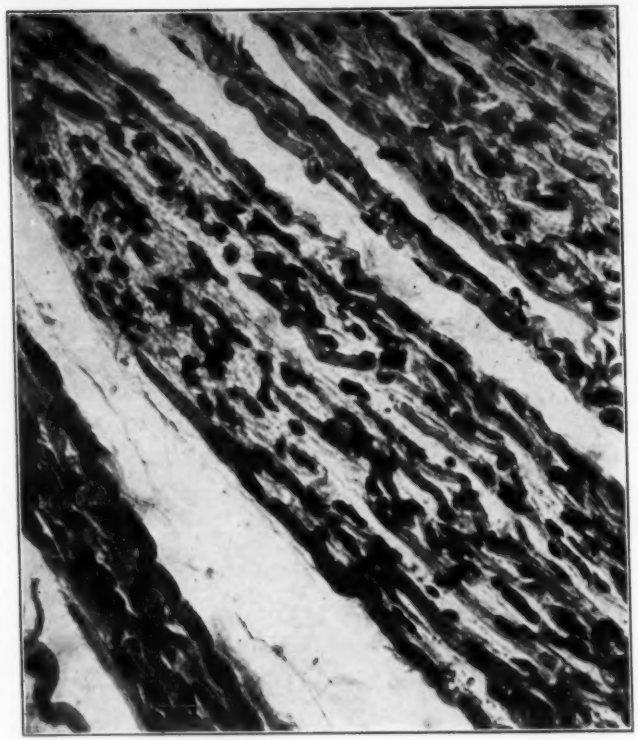

FIG. 7

Photomicrograph of left tibialis posterior, showing waviness of fibers, increase in number of nuclei, and loss of sarcoplasm.

FIG. 8

Photomicrograph of right peroneus longus, showing fibrosis of muscle fibers and hemorrhage. This section shows a mild degree of hemorrhage as seen in other muscles.

Extensor hallucis — left. Mild hemorrhages were seen in this section. The fibers showed a general narrowing and cross-striations were indistinct in most of them. In some fibers no cross-striations were visible. Several small areas showed atrophic changes, consisting of complete disappearance of sarcoplasm and groups of pyknotic nuclei. With the van Gieson stain a small area of fibrosis was found among the muscle fibers.

Peroneus longus — left. Cross-striations were present but very indistinct in most fibers. In some, only longitudinal striations were visible. The sarcoplasm stained well in most fibers. The nuclei were normal in appearance but increased in number. Many fibers showed lighter staining reactions and loss of sarcoplasm, which proceeded at times to complete disappearance, leaving only groups of nuclei, which were densely stained. In some areas cross-striations were lost and the muscle tissue was replaced by heavy fibrous tissue. The atrophic process involved the greater portion of the muscle in either a mild or a severe form. A small number of unusually large fibers were seen, being about twice the normal size. They stained well, showed no loss of sarcoplasm, but the cross-striations were indistinct or entirely absent. The nuclei of these fibers appeared normal.

Tibialis anterior — right. This section showed extensive hemorrhages among the muscle tissues. The fasciculi were variable in size, at times consisting of only two to four fibers separated by wide interfascicular spaces. Most of the fibers were narrowed, stained well, and showed clear cross-striations. Loss of sarcoplasm was noticeable in many fibers. The nuclei were decreased in number and indistinct.

Extensor hallucis — right. Most fibers were narrower than normal, and a few showed loss of sarcoplasm. Considerable hemorrhage was present. In regard to striations, staining reactions, and appearance of nuclei, most fibers were normal.

Peroneus brevis — right. Hemorrhage was present in about the same amount as in the other muscles. Many fibers were narrower than normal. They stained well but showed a marked loss of cross-striation. Longitudinal striations were clear. The nuclei were increased in number. There were many groups of pyknotic nuclei, and many fibers which had lost almost all their sarcoplasm.

Extensor digitorum longus — right. This section also showed extensive hemorrhage. Most fibers were narrowed. The striations were very clear in most instances, although in some fibers no cross-striations were visible. The nuclei were increased in number and stained deeply. Individual fibers showed variable degrees of loss of sarcoplasm. With the van Gieson stain several areas were noticed where whole fasciculi showed fibrosis.

Peroneus longus — right. Hemorrhages were present as in the other muscles. There was a general narrowing of the fibers. The nuclei were increased in number. The muscle fibers stained well but cross-striations had disappeared in most of them. The most marked evidence of atrophic change was the fibrosis of the muscle. In many areas may be seen small fasciculi of muscle fibers among connective-tissue fibers which apparently were newly formed. Some of these muscle fibers stained well, had clear striations, and appeared normal. Others showed varying stages of atrophy, as loss of striations, loss of sarcoplasm, hyalinization, and often only groups of nuclei within the sarcolemma tubes. Such a process involved in some degree a large portion of the muscle. By means of the van Gieson staining method it was estimated that about one-third of this section consisted of fibrous tissue (Fig. 8).

Gastrocnemius — right. Hemorrhage was less severe than in the anterior muscles, being limited to small groups of red cells among the fibers or between the fasciculi. The fibers were all narrowed, and in some sections showed a coarse waviness. About one-half of the fibers showed cross-striations, nearly always indistinct and in some barely visible. The remaining fibers showed no cross-striations. There were variable amounts of loss of sarcoplasm in nearly all fibers. The nuclei were increased in number but otherwise normal. With the van Gieson stain, a small area of fibrosis was noted.

ANALYSIS OF CHANGES IN MUSCLES

Hemorrhage. The presence of hemorrhage found in certain muscles is not entirely understood. There was considerable variability in regard to the location and the extent. In the left leg, only one muscle, the extensor hallucis, showed the presence of red blood cells and this was very mild. In the right leg, however, all the muscles that were examined showed hemorrhages, varying in amount and in age. The gastrocnemius on the right contained numerous small areas which were infiltrated with blood, but here it was never very extensive. For the most part, hemorrhage consisted of small groups of red blood cells, situated in the interfascicular tissues, and seldom found its way into the fasciculi proper. On the other hand the peronei, tibialis anterior, extensor hallucis, and extensor digitorum longus contained many areas of profuse and extensive amounts of blood. In some instances the appearance of the red blood cells indicated that the hemorrhage had been present for some time, as the erythrocytes had changed in color and had lost their regular contours. In most areas, however, the hemorrhage appeared to be recently developed.

The blood vessels in the sections that were hemorrhagic were examined for pathological changes, but these were entirely normal.

The occurrence of hemorrhage is not ordinarily associated with deformities of the feet, when studied clinically. It has, however, been frequently mentioned by Bagg in his investigations of the effects of roentgen rays on mice. Bagg has described a number of malformations of the eyes, limbs, and other parts of the body, occurring in descendants of irradiated white mice. The most common deformity of the feet was club-foot, although polydactylism, syndactylism, and hypodactylism were also noted. Certain feet at birth had dark spots indicating blood pigment. Bagg believes that the foot abnormality is definitely associated with a localized arrest in development accompanied by a disturbance to the blood supply of the foot.

The presence of the hemorrhages, as seen microscopically in the muscles, is apparently sufficient reason for the discoloration which was noted grossly. The amount of extravasation seems to be in direct proportion to the intensity of the color in the different muscles.

From the information gained in the examination here, it would be impossible to state what significance the hemorrhages have. As they are not frequently found in congenital anomalies, it is quite likely that they disappear early by absorption.

Anatomical Changes in Muscle. In reviewing the microscopic findings in the muscles which were examined, it is evident that variable degrees of pathological conditions exist. It seems that some investigators have at different times considered two separate and distinct types of atrophic change: simple atrophy and degenerative atrophy. This subject has been thoroughly reviewed by Rosin, who has examined the muscles, nerves, and spinal cord in cases of war injuries. According to this writer, a simple atrophy consists of a narrowing of muscle fibers accompanied by

nuclear hypertrophy, formation of chains or groups of nuclei, and retention of the specific fiber structure. In degenerative atrophy the normal fiber structure is disturbed or lost, usually with simultaneous fatty, waxy, or vacuolar degeneration, the fiber finally disintegrating into single masses of protoplasm rich in nuclei (myogenous giant cells). Rosin concludes from her studies that a sharp differentiation between the simple and the degenerative atrophy of disuse is impossible, as there are many transitional forms between the two.

The microscopic appearance of the muscles in this case suggests very strongly a combination of the two types of atrophy. In many of the sections the changes were mostly such as are ordinarily considered to be the results of simple atrophy. Yet the same muscles may show changes of a more advanced degree so that they correspond accurately to forms of degenerative atrophy. Also some muscles showed alterations throughout the whole section which were distinctly more pronounced than in other muscles. The appearance of the gastrocnemius on each side was such that the atrophic process was less marked than it was in the anterior muscles of the leg. The tibialis posterior on the left was partly normal and partly involved in atrophic changes which had progressed in some areas to complete disappearance of the fibers. The atrophy was most conspicuous in the peronei, where it resulted in many areas in complete disappearance of muscle structure and replacement by fibrous tissue.

The question of preservation of individual fibers among the atrophied tissue is unsettled. Rosin mentions this and calls attention to different views which had been expressed to explain the difference in degree of atrophy. It was suggested that it might be the result of variability in the age and the resistance of the fibers. Also mention was made of the difference between red and white muscle fibers. In this connection Grutzner stated that red fibers are more resistant than white fibers (Rosin). Cobb has pointed out that there is no sharp line of distinction between the two types, as many intermediate varieties of fiber may be found. Fulton divides muscles into a primitive type with small fibers and centrally placed nuclei, and a more highly developed type possessing less sarcoplasm, clear striations, and peripherally situated nuclei.

In comparison to anatomical alterations reported by different investigators of muscle pathology, it is evident that the condition of the muscles here was not very markedly changed. However, it is to be remembered that an advanced degenerative atrophy may require a long time and it is quite likely that the pathological alterations in an older case would be more extensive. We recall in this connection that Rosin found normal fibers in muscles which otherwise were completely atrophied. Ricker and Ellenbeck found that, in cases of nerve section, cross-striations never disappeared from the fibers up to 125 days after section, and could be seen even in fibers where the sarcoplasm showed marked changes.

This leads to a consideration of the neuromyopathic conception of the origin of congenital club-foot, which has been proposed by a number of

different authors. This would imply that the position of the deformed foot is brought about by physiological influences dependent on muscular imbalance; a disturbance of the synergy between the group of adductors, flexors, and supinators on the one hand, and the abductors, extensors, and pronators on the other. Rust, in 1831, stated, "This malformation is the result of a disturbance in development, a retained overactivity of the adductors and flexors, so that they produce a twisting of the bones. Accordingly we find nearly always that the muscular apparatus of the leg is incomplete, the muscles are small, thin and pale." Dieffenbach suggested two possibilities functionally for the development of the deformity, (1) an abnormally increased power of one group with normal conditions in the antagonists, (2) diminished power, a paralysis of one group, with normal antagonists.

Volkmann, in examining the body of a new-born infant with club-foot on one side and flat-foot on the other, found that the muscles and nerve fibers of the supposedly paralyzed muscles differed from those of the back only in this, that they were quantitatively underdeveloped. Degeneration of cells and fat metamorphosis, as they appear usually in such tissues in paralysis, were completely absent. The muscles of the lower extremity had been more or less inhibited. This inhibition was irregular, as some muscles were much less developed than others. The histological examination showed that in the involved muscles the primitive bundles were so constituted that they appeared to belong to an embryo of two to four months rather than a full-term child. Entire fasciculi and bundles consisted of elements which were only one-third, one-fourth, or one-eighth as strong as the muscles of the upper extremity and the back, from which controls were taken. Among the bundles of muscle fibers which were delayed in development there were always, in the same muscles, bundles of larger and more normal fibers.

Kraffert reported a case of club-foot with bilateral aplasia of the extensor digitorum longus. Bülow-Hansen in twenty-eight cases of relapsed club-foot found degeneration of the peronei in nine cases at operation. Clauss described macroscopically visible differences in regard to the color and volume of the individual muscles. Mostly the peronei, especially the peroneus longus, and the extensor digitorum longus were affected. Various forms of degeneration were noted grossly, but no microscopic examination was made. Pfrang, in examining a specimen of congenital club-foot of an adult, noted that the peronei were well developed, the Achilles tendon was weak, and the flexor hallucis was the only muscle which was definitely atrophic. No microscopic examination was made.

White has recently expressed the opinion that in certain cases of congenital club-foot, the deformity is produced by the action of the tibials, especially the tibialis posterior, and that this may be largely due to injury of the peroneal nerve during intra-uterine life. The importance of the tibialis posterior in its relation to congenital club-foot has been emphasized by Ludloff. H. v. Meyer stated that only a primary contracture of the tibialis posterior could be responsible for club-foot (Mau).

In view of the type of deformity produced in club-foot and the numerous instances in which anatomical or physiological disturbances have been noted in the muscular apparatus, it seems justifiable to assume that there is a close relationship between the two. However, this will be referred to later.

EXAMINATION OF NERVES

The nerves which were examined were the tibial and the common peroneal nerves on each side, the specimens being taken from the lower third of the thigh. In addition the deep peroneal nerve on the right side was examined. The nerve tissues were imbedded in gelatin, sectioned, and stained with the hematoxylin-eosin and the Spielmeyer methods.

In all the nerves examined small hemorrhages were found. In the section of the left tibial and peroneal, this was present in only one of a series of sections. In this it involved the peroneal nerve only in the perineurium of one small funiculus. In the same section the tibial nerve contained an area of hemorrhage in the perineurium of several funiculi, and also numerous red blood cells scattered through several funiculi.

The right tibial and peroneal nerves contained hemorrhages which were more numerous and more extensive than those of the left. They were located mostly in the epineurium and in the perineurium, but were also present in mild form in the endoneurium.

The deep peroneal nerve of the right leg showed hemorrhages in most of the series of sections. They were confined mostly to the epineurium and to the perineurium.

The principal feature, histologically, of the nerve trunks was the distribution of myelin. In this there was no visible difference between the nerves of the two sides, but on each side the tibial nerve was noticeably better supplied with myelin. There was also a difference in distribution of myelin between the different funiculi of the same nerve and even between different portions in the same funiculus (Fig. 9).

With the hematoxylin-eosin stain the nerve tissues showed many nuclei, apparently sheath-cell nuclei, being regularly distributed throughout the nerve trunk. They were normal in contour, staining reaction, and size. None of the nerves showed sclerosis, fibrosis, or degenerative changes.

The condition of the peripheral nerves in congenital club-foot has been very little studied for the reason, perhaps, that nerves are not readily available for anatomical study in living patients. In the case of v. Recklinghausen the peripheral nerves in the leg were reported normal, although in the same patient the nerves of the sacral plexus showed a definite sclerosis and were poor in fibers microscopically. Ribbert in a case of spina bifida occulta found no pathology in the sciatic nerves. Hackenbroch examined seven foetuses with club-foot and failed to find any abnormalities of the nerves in the lower extremities. Roeren states that the nerves are poor in fibers. Klebs and Sutton both found a fatty infiltration of the tibial nerves in cases of spina bifida occulta, and the nerves arising from the injured cord level were much thinner than normal (Beck).

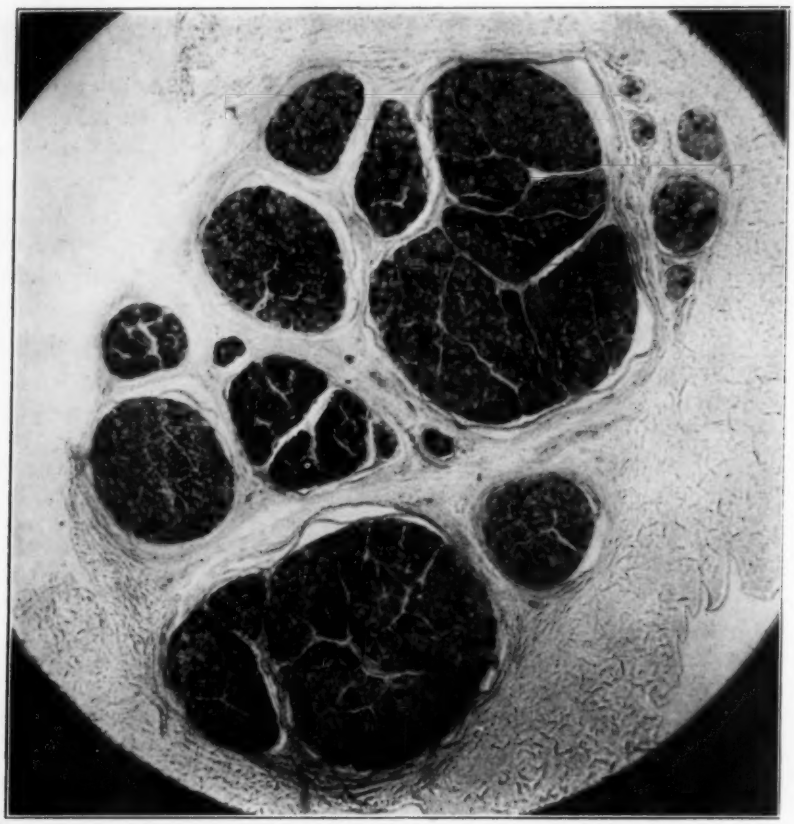

FIG. 9

Photomicrograph of left tibial and peroneal nerves showing difference of distribution in myelin.

The difference in the size of the nerve trunks between the two sides was not as striking when examined microscopically as it was on macroscopic examination. Whatever peculiarities were observed here in the distributions of myelin, may perhaps be accounted for by the fact that at this stage of development of the foetus, myelinization would not be expected to be complete. Bearing in mind that the motor and the sensory nerves are not myelinized at the same time, it is not difficult to understand why some portions of the nerves would be more richly supplied with myelin. When we consider further the presence of intraneural plexuses, we have an explanation for the irregularity of distribution of myelin, not only in different funiculi of the same nerve, but even in different portions of the same funiculus. Our knowledge of the presence of intraneural plexuses has been derived largely from the studies of Heinemann, Langley and Hashimoto, Compton, McKinley, Goldberg, and others. These investigations led to results which were very constant and established the fact that nerve structure is not arranged according to a fixed pattern, as had been previously

supposed. Rather it proved that in a nerve trunk there is a more or less continuous fusion and division of the various funiculi, a constant interchange of fibers between the various funiculi of the nerve, and that the component portions of a nerve trunk are not purely motor or sensory, or destined to subserve a particular function, depending on the topographic situation in the nerve trunk. With these factors in mind, there seems to be little difficulty in explaining the distribution in myelin; and also it raises the question whether the conditions noted here are really pathological. It has been suggested by Leadbetter that there may be a delay in myelinization of the nerves in club-foot, and while the condition here indicates an incomplete myelinization, there is no way to decide from the information available at present whether that feature is permanent.

ELECTRICAL REACTION OF MUSCLE IN CLUB-FOOT

Very few reports are available in regard to electrical excitability of muscles in congenital club-foot. In v. Recklinghausen's case, electrical examination of the peroneal nerve showed only the extensor hallucis longus active. The rest of the foot muscles and the peronei on stimulation with very heavy currents were not excitable. The gastrocnemius of the affected side reacted better than that in the normal leg. According to Mau's observations a definite reaction could not be produced in the peronei or tibialis posterior with either the galvanic or the faradic current. Leadbetter found in ten cases examined, that the peronei produced a very sluggish reaction to the electric current, whereas the tibials and the posterior groups reacted rather sharply.

MICROSCOPIC EXAMINATION OF SPINAL CORD

The spinal cord was examined at two different levels; one specimen being taken from the portion of the cord situated in the sacral canal, the other from the portion situated in the lower lumbar region. The tissues were embedded in gelatin, sectioned, and stained by means of the hemotoxylin-eosin and the Bielschowsky methods. Both levels showed minute hemorrhages, apparently recent in the anterior portions of the cord. These were more numerous in the lower level of the cord. The cord was at both levels symmetrical and showed no sclerosis, fibrosis, or degenerative changes.

SPINA BIFIDA OCCULTA AND CONGENITAL CLUB-FOOT

The association of congenital club-foot with congenital anomalies of the spine, particularly spina bifida occulta, has long been a matter of great interest. The term spina bifida occulta was applied by Virchow to a cleft of the sacrum and fifth lumbar vertebra associated with a hypertrichosis. V. Recklinghausen in 1886 gave an accurate description of an extensive malformation of the spine combined with a unilateral club-foot. Similar reports were made by Ribbert, Jones, Bohnstedt, Joachimsthal, and others.

In more recent years, with the advent of the x-ray, it was found that such malformations were by no means unusual; that they were frequently present in cases of paralysis of the lower extremities and in deformities which were either congenital or acquired postnatally. It was also discovered that external manifestations of the spine as scars, hypertrichosis, and pigmentation were found in a very small percentage of cases which roentgenographically revealed spinal clefts.

The incidence of spina bifida occulta shows wide variation according to different investigators and according to the age of the individual. Hintze found clefts in ninety-one per cent. of children from one to two years of age, and noted a rapid decrease with increase in age. At eleven to fifteen years it was present in three and six-tenths per cent. Grassner in 492 roentgenographs of adults found clefts in ten per cent. in the lumbar and sacral region. V. Finck believes it to be present in thirty-five per cent. of all people. Beck's investigations revealed spina bifida occulta in three and five-tenths per cent. In a series of anatomical studies, Willis noted the presence of central laminal defects in one and two-tenths per cent. of 850 specimens.

In 1920 Peltesohn expressed the belief that the majority of cases of congenital club-foot show a spina bifida occulta. Beck states that cases showing a tendency to recurrence are to be examined for a central disturbance or degenerative nerve changes occurring with spinal defects. In thirteen cases over six years, Beck found spina bifida occulta eight times by x-ray examination. Also in eighteen cases under six years a cleft was found in the fifth lumbar or first sacral vertebra. Clauss reported the occurrence of laminal cleft in seven out of eight club-foot specimens. Steindler, in thirty consecutive cases of congenital club-foot, found spina bifida occulta in eighteen. Gill states that it occurs frequently in a routine examination of the spine, in club-foot cases.

PATHOLOGY OF SPINE, MENINGES, CORD, AND NERVE ROOTS

The principal points of interest in the case described here, are the sacral cleft, the attachment of the meninges to the subcutaneous tissue mass, the low position of the spinal cord with necrosis of the terminal portions, and the upward course of the nerve roots to reach their exits. Perhaps the most important pathological features which have been reported by other writers are the soft-tissue masses, — as lipomas, and myofibrolipomas occurring in the lumbar and sacral regions, and combined with spinal defects. Gowers in 1884 reported a fatty tumor involving the conus medullaris. This, on microscopic examination, consisted mostly of fat tissue with a small amount of fibrous tissue and striated muscle. In addition the spinal cord showed a well marked sclerosis. V. Recklinghausen described a myofibrolipoma extending from the subcutaneous tissues through a cleft of the sacrum and involving the spinal cord and the cauda equina. The conus medullaris was at the level of the second sacral segment. The tumor mass was found to contain nerve bundles, and sections of the spinal cord showed masses of fibrous

tissue around the posterior and lateral columns. Bohnstedt discovered a myofibrolipoma extending through a sacral cleft and involving the roots of the cauda equina. Here also, there was a lengthening of the spinal cord. In Ribbert's case, a tough, fibrous band proceeded through a spinal cleft and involved the spinal cord. The conus medullaris was at the level of the fifth lumbar segment. Intradurally the mass, which consisted mostly of muscle fibers, partially surrounded the spinal cord, and many of the nerve roots proceeded through it. Histologically the cord was affected mostly in the dorsal half and degeneration was most prominent in the posterior roots and in the dorsal horns. In the tumor mass, nerves were seen which in part looked normal and otherwise were poor in fibers.

The first report of surgical intervention for relief in such conditions is that of Jones, who resected a wide fibrous band under a sacral cleft in a patient with paralysis and trophic disturbances of the lower extremities. Maass found at operation a subcutaneous lipoma extending through the clefts of the lumbar vertebrae and constricting the dural sac. Katzenstein removed a fibrolipomatous band extending from the subcutaneous area through a cleft and involving the dura. Voelker resected a fibrous tissue mass between a cleft of the second lumbar vertebra and the dura.

Cramer reported similar findings as a result of operations in nine cases of spina bifida occulta. Of these, eight were ten to fourteen years old and one was twenty-four years old. The pathological features were (1) fibrotendinous bands beginning subcutaneously or from muscular aponeuroses and proceeding through the laminal defect or between two spinous processes. They were traced into the spinal canal where they ended in abnormal fatty masses and constricted the cauda equina, in some cases circularly, in others by adhesions of the bands to the dura; (2) outside and inside the canal were small masses of fat, lipomas adhering to the dura or overlying it; (3) in some cases the end of the dural sac was abnormally high; (4) changes in the arrangements of the nerves: defects, asymmetries, nerve fibers without myelin, traction on the cauda equina. Microscopically these structures consisted of fat cells and fibrous tissue; no nerve elements were found.

Kochs, in a case of paralysis of one leg, combined with clefts of the lower thoracic, lumbar, and sacral vertebrae, found at operation several bony overgrowths and numerous fibrous bands between the dura and the cleft. The deformity, paralysis, and trophic disturbances disappeared after operation. De Vries reported a case of spina bifida occulta with a unilateral club-foot developed in adult life. At operation a dense fibrous tissue mass was found under the arches of the fourth and fifth lumbar vertebrae and compressing the dura. Brickner performed operations in twelve cases of spina bifida occulta. He states that the results are not brilliant, probably for the reason that the degenerative processes are scarcely remediable. He considers operative procedures indicated as a preventive measure in infants and children with signs but no symptoms, and in adults where the condition is serious and progressive.

Hackenbroch reported a series of seventy cases of hollow-foot which were considered the results of spinal malformation and the accompanying pathological conditions. At operation the findings were positive in sixty per cent. A definite improvement was found in about one-half of the cases with positive operative findings. Spastic conditions were relieved, exaggerated reflexes diminished or disappeared, the feet which previously were cold and cyanotic assumed a normal appearance, and deformities either failed to appear or were limited to a mild degree.

The conditions in the spinal cord show a wide variation. They consist mostly of inequality of volume of the anterior horns, atrophy, and diminution of cells of the anterior horns and Clarke's columns, degeneration in the pyramidal tracts and sclerosis in the posterior tracts and the pyramidal tracts (Mau). However, in a number of instances the appearance of the spinal cord in club-foot is entirely normal. Hackenbroch in examining seven foetuses with club-foot found no pathological changes, and concluded that whatever disturbances exist must be of a functional rather than a morphological nature.

The arrangement of the nerves in many instances where extensive abnormalities are present, is usually disturbed. This may consist of involvement of the nerve roots in soft tissue masses as lipomas or myofibrolipomas which produce pressure or traction. In some cases nerve fibers were present in these tissue masses, indicating a process of ingrowth of the nerves into the structures. Where the spinal cord was prevented from ascending to its normal level, the course of the nerve roots was altered, at times to the extent where they had to proceed obliquely upwards to reach their exits.

In attempting to explain the presence of such abnormal structures as myofibrolipomas and fibrous bands, it is quite generally agreed that they make their appearance at a very early period of embryonic life, probably not later than the beginning of the third week. According to v. Recklinghausen "this arrangement is positive evidence that the disturbance occurred at a time when the muscle germs differentiated from the anlages of the laminal arches, but that the laminal arches left open a path for the muscle masses to gain entrance into the interior of the cartilaginous canal. . . . Nothing opposes the assumption that the fat tissue entered the canal at the same time as the muscle."

Among the abnormalities in the case presented here, it seems that the primary disturbance was the failure of the sacral arches to develop. This permitted entrance of the subcutaneous tissues into the canal. The subcutaneous mass during development apparently was in close relationship to the meninges only, and had no opportunity to reach the more deeply lying structures as the cord and the nerve roots. It was evident also that the cord was prevented in its ascent by the traction of the subcutaneous tissue on the meninges. According to the investigations of Ranke, the conus medullaris in the fifth to sixth foetal month has ascended to the lumbar canal and at birth is situated at the level of the third lumbar vertebra

(Beck). From this we may estimate that the conus in this case should have been at the level of the fourth lumbar vertebra. However, here no conus was present and the end of the cord was at the level of the second sacral segment where it bifurcated.

The sudden termination of the two portions of the cord immediately after their bifurcation, is not entirely clear. While the lower end of the dural sac was filled with old hemorrhagic material, it was found that this was not extensive. The lack of any degenerative changes, even in the lower portion of the spinal cord, seems to justify the belief that the necrosis was not produced by the hemorrhage or by pressure of the subcutaneous tissues through the sacral cleft. It seems reasonable to attribute this change to the influence of the lower nerve roots, which by their abrupt turn to proceed upwards to their exits produced a flexion of the cord portions in that area, and by continuous traction severed their connections with the cord at that level.

THE THEORY OF MYELODYSPLASIA

This doctrine was originated in 1909 by Fuchs and was used to explain a rather extensive symptom-complex, including sensory, motor, trophic, and visceral disturbances, either with or without a spinal cleft. The idea has been further supported by Cramer, Roeren, Beck, Mau, and others, to account not only for congenital club-foot, but also for a large group of disturbances, manifested by all or some of the symptoms mentioned by Fuchs, and associated with developmental defects as spinal clefts or intraspinal myofibrolipomas.

Roeren calls attention to the topography of the cell columns in the embryo. The cell columns whose functions produce a plantar flexion of the foot and a raising of the arch, begin lower and extend more caudally than those from which the nerves to the extensors of the toes and the tibialis anterior are derived. The developmental arrest taking place at the lower end of the cord would involve in a quantitative sense mostly the adductors, plantar flexors, and excavators. Roeren also states, "All in all the first cause of progressive deformity is congenital malformation in the cord and consists of two components: (1) in mild cases a decrease of limit of tolerance by the influence of centripetally inflowing stimuli; (2) clean-cut organic defects in the motor and less in the sensory area. These pathological conditions may remain latent for indefinite periods of time. In function increased above a certain limit, we have the most important factor to produce foot deformity. This is supplemented by the influence of atypical attachments and tumors."

Beck emphasizes the occurrence of congenital defects in the anlages of the cord, cauda equina, and nerves, and degenerative changes in the nervous system due to tumors and fibrous bands. He believes that congenital club-foot is brought about by a disturbance of the central nervous system which produces a disturbance in the reflex arc in the cord.

Mau feels certain that the primary disturbance in club-foot is one which

involves first and foremost the spinal cord. This is believed to be the seat of the aplasias, hypoplasias, and metaplasias which are referred to as the important factors in the causation of club-foot and allied conditions. He states, "Defects of the spinal canal are secondary appearances of a primary hypoplasia of the medullary plate, and here in the hypoplasia of the medullary plate is the solution of the etiologic problem of idiopathic club-foot". And further, "According to our conception the disturbance of the anlage of the medullary canal is always the primary developmental defect; the spina bifida occulta, if it remains over the physiological time limit, is the secondary defect, dependent on central nervous influence".

In regard to the occurrence of congenital malformations of the spinal cord, it seems justifiable to suppose that such defects would be demonstrable morphologically, especially when they produce effects like congenital club-foot, paralytic and sensory disturbances. The number of instances in which anatomical changes were present in the spinal cord, is extremely small. In cases where they were found they were, in some at least, associated with other pathological changes, which probably were the primary influence in altering the appearance of the spinal cord. In addition, in case of a primary malformation of the cord, it is doubtful whether a defective area would ever develop sufficiently to gain normal function. Applying this hypothesis to a case of club-foot, it should be impossible ever to get a cure or an improvement in the deformity of the foot. Considering further the numerous cases which have been termed "myelodysplasia," where the paralytic, trophic, or sensory disturbances made their appearance postnatally, it would be difficult to attribute these to a hypoplasia of the cord developed during embryonic life. And finally, if a spina bifida occulta is the secondary effect of a primary hypoplasia of the cord, as Mau states, how are we to account for the numerous instances of spinal clefts which are entirely symptomless?

GENESIS OF CONGENITAL CLUB-FOOT

A consideration of the deformity in club-foot suggests a number of different processes which may be instrumental in bringing about such a condition. There are, of course, a few instances in which the position of the foot is very clearly produced by mechanical agencies, or by defective development of certain portions of the foot. However, the majority of cases of club-foot do not present these features. The relations are such that they may well be considered the results of a muscular imbalance of the foot, brought about by the predominance of the flexors, invertors, and supinators over their antagonists. The few observations which have been made of the disturbances of muscles and nerves are, no doubt, insufficient to permit definite conclusions. Yet they indicate that certain features are fairly constant. The reports on muscle pathology, though in many cases lacking histological examination, emphasize the occurrence of pathological changes in the peronei; less frequently the extensor digitorum longus and the tibialis anterior are altered. These are the very muscles in which disturbances would be expected to be present. The defective function of the peronei is further substantiated by the manner in which they react to electrical stimulation.

The anatomical condition of the nerves supplying these muscles has received very little attention, but in most instances normal findings were reported. However, this may be due to the fact that estimates of the functional capacity of the nerves have been made on qualitative rather than on quantitative determinations. The results obtained from electrical examination indicate nerve damage which, however, may be only a physiological interruption of the nerve structures. The neuromuscular inhibition, from a consideration of the alterations in muscles and nerves, and from the electrical reactions, are such as would be brought about by abnormal function of the peroneal nerve. We have in this connection, perhaps, additional evidence of peroneal nerve involvement by the fact that fifteen per cent. of the club-foot cases have also an inward rotation of the leg at the knee (Mau). This may be brought about by a pathological condition of the short head of the biceps femoris, which receives its nerve supply from the common peroneal nerve.

The peroneal nerve during embryonic development is in a favorable position for harmful influences. Its origin, according to Hardesty, is from the fourth and fifth lumbar and first and second sacral segments, irrespective of the type of sacral plexus. Stookey states that in a prefixed plexus it consists of roots from the third, fourth, and fifth lumbar and the first sacral segments, and in the postfixed type of plexus it is formed by roots of the fifth lumbar and first, second, and third sacral segments. However that may be, the fact remains that topographically the component portions as they arise from the cord are situated at the level at which spinal defects are most common, — the lower lumbar and upper sacral region. In addition it consists of dorsal branches and as such has a more dorsal origin than the ventral branches. We know from numerous investigations that spinal clefts are relatively common. The occurrence of abnormal structures as lipomas, fibrous bands, etc. is frequently associated with such defects of the spine. It seems reasonable to suppose that an abnormal structure brought about by a transposition of tissue in the sense of v. Recklinghausen, would be in close relationship with the outgrowing nerves, and of these the component portions of the peroneal nerve by their topographic position, would be more likely to meet obstacles than other nerves. From the reported findings of nerve tissues in myofibrolipomas in that area, we have reason to believe that the nerve roots may enter these structures instead of pursuing their normal course. Under such conditions the nerves would be irretrievably lost to the structures which they were destined to supply. Another possibility is that the nerve roots proceed through these structures and continue their course. And in addition we may have a process by which the ingrowing tissue surrounds the nerve roots. Then later, due to the disproportion in the rate of growth between the spine and the cord, the latter ascends, producing traction on the nerve roots by the fibrous bands which are usually attached to the spine or the cleft.

We would expect from an involvement of the peroneal nerve in such manner, that many cases of club-foot would be accompanied by sensory disturbances in the areas supplied by the sensory fibers of that nerve. As a

rule such disturbances are lacking and probably for the reason that the anterior and posterior roots of the cord do not develop at the same time. Allen has shown in the shark embryo that the motor fibers of the spinal cord develop considerably in advance of the sensory; but the cells destined to become neurolemma migrate from the ventral lateral surface of the spinal cord at a later date than those from the dorsal root. Hertwig states that in man the dorsal nerve root becomes visible somewhat later than the ventral. As sensory disturbances are found in some cases of congenital club-foot, and even more frequently in combination with paralytic conditions of the lower extremities when associated with spina bifida occulta, it is evident that the sensory component of the peroneal nerve may be affected as well as the motor. However, in cases where sensation is normal it would be impossible to tell, in the light of our present knowledge, by what mechanism such effects are avoided or obscured.

It is a well known fact that congenital club-foot presents variable degrees of severity, manifested principally in its response to treatment. Many cases present very little difficulty in the correction of the deformity and the maintenance of the corrected attitude. On the other hand, in a limited number of instances, there is a very decided tendency for the foot to relapse into a faulty position after correction. On the basis of a neuromuscular involvement in which the primary effect is produced by the developmental relations of the nerve roots in the lower spine, it seems that the variability in the severity of the deformity can be attributed to a quantitative variability in the involvement of these nerve roots. As the peroneal nerve has its origin over a length of four segments of the cord, it is conceivable that an interference with the constituent portions of the nerve roots as they emerge from the cord, may include all the roots or only a part of them. Such an interference can be brought about by fibrous bands or lipomas, which subsequently would interrupt the function of the nerve by traction. Thus it is not difficult to see how a portion of the component parts of the peroneal nerve may escape such harmful influences and perform their function normally. Under such conditions a club-foot which has a portion of the muscles of eversion and extension under normal physiological control, would respond better to treatment and offer a better chance for a cure than a foot in which the whole motor function of the peroneal nerve would be deficient.

The innervation of the skeletal muscles in the extremities is so arranged that every muscle is supplied by nerves from more than one segment. The subject of plurisegmental innervation has been thoroughly reviewed by Fulton (Chap. VI), who presents anatomical and physiological evidence for the occurrence of such an arrangement. On the basis of plurisegmental innervation of muscles, we probably have an adequate explanation for the presence of normal muscle fibers among the bundles of degenerated muscle tissues as reported by Volkmann.

An analysis of the findings in the writer's case suggests that here a somewhat different mechanism was operative in the production of the deformity, although the primary defect was the malformation in the sacral

spine, which is believed to be also the primary defect in all cases of congenital club-foot having a neurogenic basis. While the degenerative changes here were most pronounced in the peronei and the anterior muscles of the leg, they were also present in the gastrocnemii, though less marked. The appearance of the nerves indicated that the tibial nerve on each side was somewhat better supplied with myelin than the peroneal nerve. However, the arrangement of the structures in the lower spine was such that we would expect the roots of the tibial and peroneal nerves to be equally affected by the process of traction on the cord or roots. The occurrence of pes equinovarus under such conditions, may be explained by Auerbach's law for all typical forms of paralysis, — "Those muscles or muscle groups are paralyzed most rapidly and most completely, and recover least rapidly and least completely, which have the least power (expressed in terms of muscle weight) and which have to perform their functions under the most unfavorable physical, physiological and anatomical conditions, whereas those which in this respect are better situated largely escape paralysis." (Rosin.) Application of this law to the muscular changes noted here, would have to consider the predominance of power and the mechanical advantage which the flexors, adductors, and supinators have over their antagonists. And with this in mind it is easy to understand why the neuromuscular disturbance here would produce a position of equinovarus, rather than some other type of deformity.

CONCLUSIONS

From a study of the literature it is evident that relatively few investigations have been made to determine the course of development of congenital club-foot. A lack of definite knowledge of the pathological conditions is probably responsible for our inadequate knowledge of the etiology, particularly the hereditary features of this deformity. Whatever observations have been made point to the probability of neuromuscular disturbances, in a certain number of cases. The evidence for a neurogenic basis of the origin of congenital club-foot consists of muscular imbalance of the foot, which seems to be closely associated with defects of the lower spine. Further investigations, both anatomical and physiological, are necessary before conclusions can be formed.

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THE USE OF FASCIA LATA IN THE REPAIR OF DISABILITY AT THE WRIST

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The purpose in presenting this case is to call further attention to the use of fascia lata in a rather unique case.

About the same time that this operation was planned and carried out, Dr. Milch of the Hospital for Joint Diseases in New York reported a somewhat similar case. In a conference with him some months afterwards the discussion of these cases proved very enlightening. Feeling that it may be of some use to others, it is presented because of the satisfactory clinical result which followed the operation. We realize, however, that there may be some question as to whether this can be classified specifically, as a true Madelung's deformity; it is slightly atypical and a definite radius curvus exists with a malformation of the lower end of the radius. It meets many of the requirements, however, which Madelung describes, as in the backward subluxation of the end of the ulna with the failure of stability due to lack of, or stretching of the radio-ulnar ligament and the fact that weakness of the wrist progressed to the point of painfulness. This has been eliminated by the procedure described.

Our thought in the use of the fascia, passing through the radius and around the neck of the ulna outside the periosteum, was to bind the two bones more closely together by acting somewhat like the orbicular ligament at the head of the radius. This seems to have been accomplished and adds greatly to the stability of the wrist. A later procedure, a secondary step, in which an osteotomy of the radius was done to reduce its curve, has placed the bones in a more parallel position and greatly increased the function in pronation and supination, without displacement of the ulna, except in a very slight degree in proportion to what it was before operation.

CASE No. 5966. Admitted July 31, 1928. Age fifteen years.

Diagnosis: Madelung's deformity with radius curvus.

Previous treatment: None.

History of complaint: About one week before admission child fell while roller-skating and injured left arm. No treatment was instituted but child stated that arm was painful enough to disturb her rest at night.

Family history: Negative.

Examination: There is a development of multiple anomalies in the bony system with bowing of the radii, thickening of the bones generally, particularly about the ankles. Both forearms are abnormal in contour, in that the radii are bowed more than normally, and the distal ends of the ulnae are more prominent dorsally than usual. There is a prominence above the wrist of the right arm, but no restriction in motion; no heat or redness; slight tenderness.

Original x-rays taken July 31, 1928. Anteroposterior and lateral views of the right forearm show a marked curvature of the radius, the convexity being outward. The distal articular surface of the radius makes an angle of about forty degrees with the plane perpendicular to the long axis of the forearm. The ulna is displaced backward and makes no contact with the carpus.

Treatment: Operation, September 8, 1928: Fascial ligament sling, radius and ulna, right. Operative technique: Longitudinal incision was made at ulnar border between the flexor and extensor of the carpus and a blunt dissection to expose the periosteum. Blunt dissection was then carried through the wrist dorsal to the two bones and ventral to the pronator quadratus to an incision on the radial border of the wrist. These two tunnels were marked with guide sutures. A large hole was then drilled through the radius, one inch above the joint in a palmar and ulnar direction. Through this a guide suture was carried forward through the drill hole, backward through the interosseous membrane, around the ulna, across the palmar surface to rejoin itself. This guide suture was used to carry a strip of fascia lata taken from the left thigh, through a longitudinal incision eight inches long, around the ulna from before backward in such a direction as to apply force, carrying the head of the ulna forward and approximating the ends of the bones. Skin was closed with No. 0 chromic catgut. Fixation on molded plaster splint.

Patient was discharged from hospital at the end of four weeks after operation, was to have baking and massage daily with active and passive motion. After approximately nine weeks of baking and massage the following condition existed: In estimation of the patient, function was markedly improved, all movements of the wrist joint being normal except for a loss of twenty-five per cent. of supination. Pain from which patient sought relief had entirely disappeared.

Operation: February 27, 1929: Osteotomy radius, right. Operative technique: Longitudinal incision was made on radial aspect of lower end of the radius at the apex of the curve; blunt dissection between the muscle planes to reach the bones; periosteum was retracted and drill hole bored through the radius in the anteroposterior plane. Osteotomy was completed with a chisel and the distal fragment deviated backward to make it lie in a plane corresponding to the ulna. Forearm was then completely supinated. Wound was closed in layers; skin was closed with dermol. Forearm was maintained in a supinated position with slight backward displacement of the radius by means of an anterior and posterior molded plaster splint.

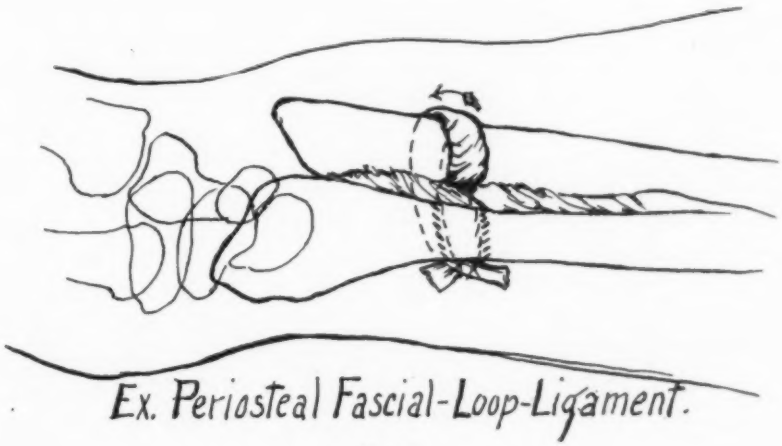

FIG. 1

Note that in supination, instead of the ulna riding backwards, it is bound to the radius and is held forward, thus strengthening the grip.

At the end of approximately three weeks patient was discharged from hospital and baking and massage begun. Four weeks later the following condition existed: In the extended position the active supination was to seventy-five per cent.; passively this could be directed to ninety per cent. The tension on the fascial sling probably slightly restricted the movement but prevented the dislocation and separation formerly existing. Pain formerly complained of at radio-ulnar articulation was absent.

X-ray October 8, 1929: One year and three months later anteroposterior and lateral views of the right wrist show the radius to be quite straight. The dislocation of the ulna has been reduced. The distal articular surface of the radius still forms an angle which is too acute, but is much improved as compared with the original films. Clinically at this time, the child reported greatly increased usefulness of her wrist; that she had had no further pain and had had no recurrence of the symptoms previous to operation. She still has slight limitation of movement toward supination, but functionally we feel that the wrist has been improved at least seventy-five per cent.

The opposite wrist, being of a much milder type, and practically having but little pain, has been left undisturbed. We feel that the weakness in one wrist accounted for overuse of the opposite one, which started symptoms in it. It seems wise to delay treatment of the other wrist long enough to see whether the condition will progress or the wrist will remain symptomless.

CONCLUSION

The use of fascia in this connection indicates that it is entirely feasible, and that it can be depended upon for a great variety of uses, and lends itself most admirably to osteoplastic and tendoplastic work.

FRACTURE DISLOCATION OF THE FOURTH LUMBAR VERTEBRA WITH PARALYSIS

Reduction of a Case with Recovery*

BY S. S. HERZIKOFF, M.D., LOS ANGELES, CALIF.

Dislocations of the lumbar vertebrae, whether or not complicated by fracture, are of such extreme rarity as to make the prompt reporting of cases within this category urgent. Review of the literature shows a surprisingly little amount written on dislocations in this segment of the spine with the exception of the commonly known spondylolisthesis. A recent article by Brailsford[1] reviews a series of three thousand x-rays of the back in which there was severe trauma associated. Not a single instance of lumbar luxation was cited. Cotton questions whether pure luxation ever exists at this level. He feels that the rather interlocking arrangement of the articular processes prohibits the occurrence of luxation uncomplicated by fracture.

Meyerding reported a case of a forty-six-year-old man who fell down a flight of steps and hurt the lower part of his back. He complained of severe low back pain radiating down into the thighs. Months later the case was diagnosed after x-ray examination, which disclosed a slight forward slipping of the fourth lumbar vertebra on the fifth, and a congenital spina bifida occulta.

Spondylolisthesis is the term applied to the condition in which there is a slipping of one vertebra on another. Although actually not restricted to any one vertebra in its meaning, time and usage have practically limited it to infer a slipping of the fifth lumbar segment forward on the sacrum. The condition was first described by Killian in 1853. Eikenbary reported a series of one hundred and thirty-one cases of compression fractures with no mention of luxation. Wilson cited a series of cases of spondylolisthesis including the fourth and fifth segments of the lumbar spine. Slipping in each case was comparatively slight. One of his patients had a spontaneous reduction with sudden relief of pain during examination. Wilson advises against depending upon external mechanical fixation alone in these cases. He reports unsuccessful attempts at reduction in cases of spondylolisthesis by traction and manipulation. In his article he recommends a Hibbs fusion operation. Although he mentions slipping of the fourth segment on the fifth, very little is said of this condition and the article stresses principally the commonly known spondylolisthesis.

It has been estimated that about ninety-eight per cent. of all vertebral luxations occur in the cervical region. Dislocations of cervical vertebrae occur much more frequently than is generally supposed and can exist with

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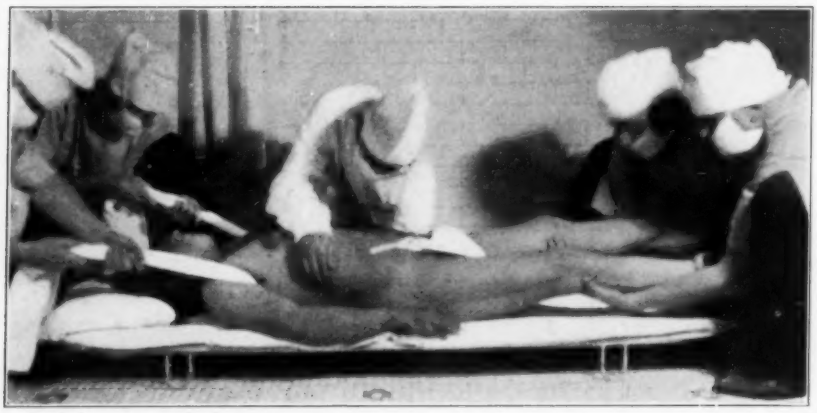

FIG. 1

Showing first part of manoeuver in reduction; strong steady traction on both legs and in axillae.

surprisingly few symptoms and little discomfort to the patient. Reduction, if the dislocation is recognized early, is usually readily accomplished, although the treatment may appear heroic.

Vance, in an article on Orthopaedic Treatment of Fracture Dislocations of the Spine, fails to cite cases of such injury in the lumbar region and stresses the use of the convex frame during convalescence. No method of reduction is described. Cole mentions a fracture dislocation of the tenth dorsal vertebra unrecognized for six months and in which an Albee operation was done as a remedial measure. McKerrow[9] cited an interesting case of dorsolumbar dislocation, in which the patient was run over by a truck

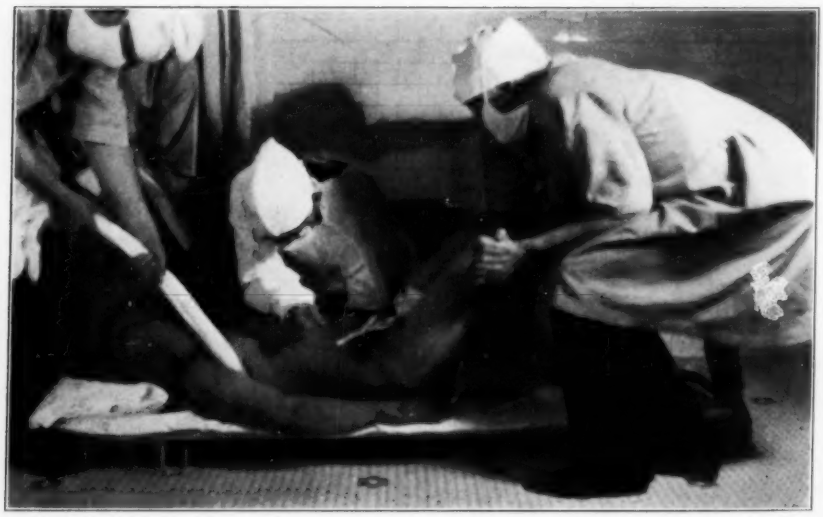

FIG. 2

Showing second part of manoeuver; full pressure of operator is placed across patient's chest as assistants rise and maintain traction.

FIG. 3
Showing final step in manoeuver.

wheel, with a resulting lateral displacement at the dorsolumbar articulation. The patient suffered loss of sphincteric control and loss of the major part of sensation and motion in the lower extremities. Open operation was necessary in the reduction of this case. He was unable to find a report of a similar injury. The result in his case was not described in the article. Marshall and Reed advise early extension and immobilization in a plaster jacket in fracture dislocations of the lumbar vertebrae. Their article also fails to cite cases. W. Förster, in 1922, cited a highly interesting case of replacement of a complete lateral dislocation between the third and fourth lumbar segments by the closed method. This was the only case report of complete dislocation with replacement found in the literature. His patient, however, after two years was still severely paralyzed and without sphincteric control.

In my review of the literature, many pages were found written regarding dislocations of cervical vertebrae and typical spondylolisthesis. Practically

FIG. 4
Showing attitude of patient after reduction. A fracture bed was used in a semi-Fowler position.

no material is available that would aid one in the handling of a case of severe fracture dislocation of a lumbar vertebra. Even the textbooks are very meager in description of treatment methods. Most of the description of treatment is along general lines and few actual cases are cited. A summary of the literature discloses that: —

1. Very little reference is made to lumbar luxation above the lumbosacral joint;
2. The consensus of opinion is that dislocation of lumbar vertebrae cannot exist uncomplicated by fractures;
3. Attempts at reduction have been rare and are only briefly referred to;
4. Fusion operation has been generally recommended;
5. The cases in which there was primarily a paralysis usually terminated with a residual paralysis;
6. Lateral and stereoscopic anteroposterior x-rays are necessary for a thorough diagnosis.

CASE REPORT

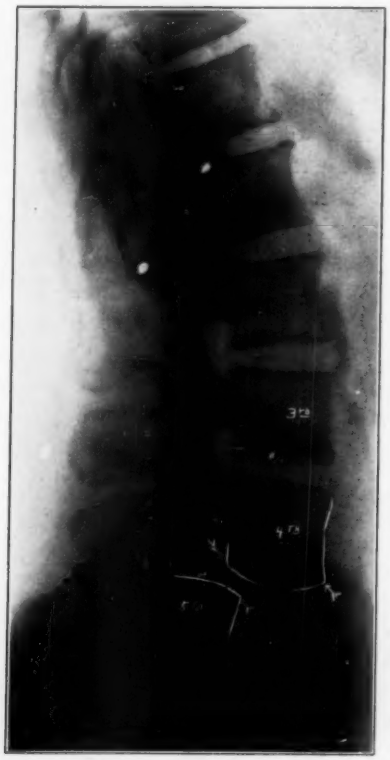

FIG. 5

Lateral view showing complete anterior displacement of fourth lumbar vertebra. The fifth vertebra is indistinctly shown in the print but is pointed out by the lower arrow.

The following case is thought to be unique because no case closely paralleling it could be found in the literature, and because we were able to reduce the deformity and maintain position by external mechanical means. The patient gives promise of an excellent recovery.

History: H. G., a laborer, age twenty-nine, was brought to the Golden State Hospital late in the afternoon of January 10, 1929. The man had been working on a small platform during the construction of a tower. The skip on a crane was accidentally swung against the patient, striking him in the right side and pinning him between the skip and the tower. There was immediate motor paralysis in both lower extremities. On arrival at the hospital the patient was seen to be in extreme shock. There was marked pallor and profuse perspiration. The pulse was hardly perceptible. The systolic blood pressure was sixty. The essential complaint was that of pain in the right side of the abdomen and the lower part of the back. After preliminary examination the patient was put to bed to be treated for the shock. A catheterized specimen of urine revealed a small amount of blood macroscopically and an albuminuria. The blood count showed a leucocytosis of 15,200; erythrocytes 4,700,000.

The following morning the patient had recovered sufficiently from the shock to

FIG. 7

Anteroposterior view before reduction. Lateral displacement of the fourth lumbar vertebra is visible.

FIG. 6

Lateral view taken immediately after reduction, showing complete replacement.

FIG. 8

Anteroposterior view after reduction. The arrows point out the multiple fractures of the transverse processes.

permit continuation of the examination. He still complained of severe pain in the right flank. Inspection revealed a large amount of ecchymosis over the right hip, flank, and lumbar areas.

X-ray Examination: Lateral and stereoscopic anteroposterior x-rays were made and revealed an anterior dislocation of the fourth lumbar vertebra on the fifth equal to the anteroposterior diameter of the vertebral body. It was also displaced laterally to the left about one-fifth the lateral diameter of the body of the bone. The superior articular processes of the fifth lumbar vertebra were fractured. It could not be clearly demonstrated whether the inferior articular processes of the fourth segment were broken. In addition there were fractures of the tip of the spine of the fourth lumbar vertebra and of the first, second, third, fourth, and fifth transverse processes on the right side and the third, fourth, and fifth on the left.

Method of Reduction: As soon as the roentgenological diagnosis was made and neurological findings noted, the patient was subjected to a general anaesthetic and an attempt was made to reduce the dislocation. The stretcher and patient were lifted from the carriage and laid on the floor. A folded sheet was slung under the patient's

arms as shown in Figure 1. An assistant took hold of each end of the sheet. Each leg was also grasped by an assistant. The operator knelt down beside the patient with one arm under the back just below the level of the luxation and the other across the patient's lower chest above the site of the lesion. The assistants then simultaneously applied steady but very strong traction so as to stretch the spinal column. At a signal they arose and approached each other slightly, in such a manner as to partially flex the spinal column and at the same time flex the thighs to an angle of ninety degrees. At the time of the second part of the manoeuver the operator leaned his entire weight on his right arm and across the patient's chest and at the same time assisted in raising the patient's pelvis with his left arm. The accompanying photographs show stages of the procedure. At no time was a jerking movement employed. The procedure involved one continuous manoeuver. The patient's body was maintained in the flexed position by the use of pillows and then placed on the x-ray table. Check-up pictures revealed a complete replacement of the anterior luxation. Reproductions of x-rays herewith show the condition of the vertebrae before and after reduction. The patient was placed on the Hawley table and a double spica plaster cast was applied extending from the upper part of the chest down to the knees. The flexion of the spine and the thighs was maintained by the cast. Further x-rays were then made and revealed that the bones were still in good position. There was a slight lateral displacement to the left. Figure 4 shows the attitude of the patient in bed after the reduction. The cast is not shown in this photograph.

Neurological Examination Prior to the Reduction: Neurological examination on the day after the injury but prior to the reduction revealed briefly as follows:

Cranial Nerves	No sign of injury
Upper Extremities	No motor or sensory paralysis
Lower Extremities (Motor)	
Voluntary abduction of thighs	Absent
Voluntary adduction of thighs	Present but diminished
Flexion of thighs	Both sides equal but diminished
Extension of thighs	Diminished
Extension of legs	Greatly reduced power
Flexion of legs	About twenty-five per cent. normal; weaker on right
Dorsiflexion of foot	Absent bilaterally
Plantar flexion of foot	Absent bilaterally
Eversion of foot	Absent bilaterally
Inversion of foot	Absent on right; weakly present on left
Dorsiflexion and plantar flexion of toes	Absent bilaterally
Internal rotation of thighs	Present
External rotation of thighs	Greatly diminished
Lower Extremities (Sensory)	
Thermal sensation	Normal

There was a band of hyperaesthesia about two to three inches in width at the level of the greater trochanters of both femora. Tactile and pain senses were present but subnormal over the area of distribution of the common peroneal nerve on the right. Reflexes: Tendon jerks in the upper extremities were present but hyperactive. The patellar, tendo Achillis, Gordon, and Oppenheim responses were absent bilaterally. The abdominal reflexes were submerged. The cremasteric reflex was slightly increased on the right. There was loss of voluntary control of the bladder and rectum.

The findings were obviously those of a lesion of the cauda affecting principally the sacral roots. The major part appeared to affect the motor fibers. The lesion was one of peripheral neurons and not the spinal cord itself.

The day following the reduction upper and lower abdominal reflexes were present; the cremasterics diminished. Slight power in the dorsiflexors of the left foot and toes was noted, as was also some power in the plantar muscles of the left foot and the posterior

muscle group of the leg. Patellar reflexes had returned bilaterally. Plantar reflexes were still absent.

Five days after the injury there was definite improvement in the left leg. The peroneal group was still very much weakened. The muscles of the right foot were still inactive. Ten days after the injury the patient voided voluntarily and it was not again necessary to catheterize him. He also had a normal bowel movement on that day. Fifteen days after the injury there was some power of voluntary abduction in the thighs. There was gradual improvement in all the musculature until at the last examination, eleven months after the injury, we found normal reactions throughout in the left lower extremity, normal responses in the right thigh and knee, but no voluntary or reflex responses in the right foot or ankle. These latter muscle groups failed to respond to the faradic current.

FIG. 9

Anteroposterior view two months after injury.

FIG. 10

Lateral view two months after injury, showing a very slight return of the deformity.

FIG. 13

Lateral view ten months after injury; no further tendency of deformity to return.

FIG. 12

Anteroposterior view ten months after injury. Study of the original x-rays reveals a firm fusion between the vertebrae at the sites of fracture of the articular processes.

FIG. 11

Lateral view five and one-half months after injury, showing no further increase in the deformity.

Postoperative Treatment: The patient wore the cast for two months. Check-up x-rays showed the reposition of the vertebrae being maintained. Massage and electrotherapy were employed for the lower extremities. After removal of the cast the patient was kept in a semi-Fowler position in order to continue the attitude produced by the cast.

A Taylor brace was supplied and four months after the injury the patient was allowed to use crutches. A foot-lift brace was supplied in order to protect the muscles of the right leg because of the existing foot-drop. Pictures made five and one-half months after the injury showed a slight forward slipping of the fourth lumbar segment.

The patient began walking with a cane six months after the injury. He continues to wear his Taylor brace a part of the time but can be without it with no discomfort. Back motion is at least seventy-five per cent. normal at this time and should continue to improve. The patient has no pain in the back. He stands erect and there is practically no visible deformity. It is interesting to note that none of the normal lumbar curvature was lost by keeping the spine flexed during the first few months of the healing process. There is still some atrophy in the muscle groups supplied by the right common peroneal and posterior tibial nerves. Whether or not there will be a return of function in these groups later cannot be stated at this time. Figures 15 and 16 show the range of back motion now present. Figure 14 is a posterior view of the patient. In it there is noted a scoliosis only perceptible on close inspection. There can also be noted in this photograph slight atrophy of the right calf muscles. The last x-rays, made eleven months after the injury, show no increase in the deformity. Study of the pictures shows enough union at the sites of fracture of the articular processes to indicate that there will be no further spontaneous displacement.

FIG. 14

Posterior view of patient eleven months after injury. A very slight scoliosis is noted. Note also atrophy of muscles of right calf.

FIG. 15

Showing flexibility of back.

FIG. 16

A lateral view of patient ten months after injury, showing the normal lumbar curve.

SUMMARY

Although only one case is cited, it is felt that the description of the procedures used may be of some value. It proves the practicability and possibility of a closed reduction. It shows that where fracture has occurred, fusion operation may not be indicated, as spontaneous fusion between the injured vertebrae may be expected. It emphasizes the relief of paralysis that may be expected by relieving the stretching or pressure that must be inflicted on the cauda or nerves as they pass between the vertebrae in marked displacements. The case is unique because of the multiple fractures, the absolute lack of injury to the bodies of the vertebrae, and the marked displacement. The early return of function and absence of pain in the back, and the recovery of most of the muscular control are encouraging.

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AN UNUSUAL CONGENITAL ANOMALY OF THE BONES OF THE LEG

BY PERCY W. ROBERTS, M.D., NEW YORK

Congenital anomalies of the bones of the leg and foot are not of uncommon occurrence, but the case illustrated in this report is of peculiar interest because of its rarity. Indeed the bone condition was overlooked by the first surgeon who had charge of the case and who directed his efforts toward correcting the accompanying deformity of the foot.

The patient, a girl seven years of age, was born with a moderate equinovarus. The father had an extreme type of congenital equinovarus in which a very useful foot was obtained by conservative treatment. During the first few weeks of the child's life the deformed foot was treated by the family physician. When a few months old she was under the care of a well known Viennese surgeon who attempted to correct the residual defect by manipulation under an anaesthetic. This was unsuccessful and a few years later she was twice operated upon by two competent, western orthopaedic surgeons.

FIG. 1

X-ray of foot and ankle of a child seven years of age, showing congenital malformation of tibia and fibula and articulation of astragalus with lower end of fibula.

When she came under the writer's observation the foot was still in equinovarus. The affected extremity was two and one-half inches shorter than its mate, and clinically there was what appeared to be a lateral deflection of the lower end of the fibula suggesting an old fracture. X-ray examination, as will be seen by reference to Figure 1, revealed a most unusual condition. The fibula, beginning at the junction of the lower and middle thirds, was shown to be flared out not unlike a normal tibia and the lower half of the tibia is tapered without any evidence of malleolar expansion. The ankle joint is formed by the articulation of the lower end of the fibula with a misshapen astragalus. Voluntary flexion and extension of the foot can be carried through an arc of about fifty degrees. X-rays taken at the age of seven months (Fig. 2) show the malformations in their early stages.

FIG. 2

X-ray of bones of foot and leg of case illustrated in Fig. 1, taken at the age of seven months.

The striking clinical feature of this case was the extreme shortening of the affected extremity, two and one-half inches, which, when the child first came under observation, was not compensated by an elevation of the shoe. She was extremely active and was little handicapped by the moderate varus deformity of the foot. While the shortening may in some degree be accounted for by a fracture of the fibula which occurred during the early manipulation of the foot, it is no doubt chiefly due to congenital disturbance in the centers of growth as indicated in x-rays taken during the first few months of life. This observation is of interest in venturing a prognosis in similar cases, which probably occur, although no report of a like condition has come to the writer's attention.

CYST OF THE OS CALCIS

BY N. ROSS SMITH, M.B., CH.M., F.R.C.S., BOURNEMOUTH, ENGLAND

Late Surgical Registrar, Royal National Orthopaedic Hospital, London

A cyst of the os calcis is rare. The accompanying skiagram shows the condition in the case of a man aged fifty-three years. He had a fall from a ladder on to his feet and subsequently complained of pain in both heels. No sign of fracture is to be seen in the skiagram of either foot and the other os calcis is in every way normal.

FIG. 1

It is doubtful whether the appearance in this skiagram is that of a cyst due to osteitis fibrosa or a mere architectural peculiarity. Mr. R. C. Elmslie, to whom the writer has submitted the skiagram, is inclined to the latter view. In any case it is interesting as a most unusual appearance.

As the bone seemed to be weakened by this defect, it was proposed to explore it and to curette the cyst, if present. The patient, however, failed to attend again.

PECTORAL MUSCLE DEFECTS

Cases Illustrating Three Varieties*

BY GEORGE A. WILLIAMS, M.D., ATLANTA, GEORGIA

Variations in the pectoral group of muscles are by no means rare. The condition usually found in the dissecting room is the absence or variation in origin of one or more heads of the pectoralis major, but the clinical observer, noting those defects which result in more marked deformity, has claimed that a complete absence of both pectoralis major and minor constitutes the most common defect.[1] Christopher[2] in an extensive review of literature on the subject, could find no record of the smaller muscle being absent without accompanying defects of the pectoralis major and concluded that it probably did not occur. It is striking that compensatory action in other muscles always serves to preclude any disability resulting from these deformities.

Case 1. R. C., a white schoolboy, age nine, was seen during a public school inspection. Asymmetry of the thorax attracted attention to the absence of both of his right pectoral muscles. The anterior axillary fold is directed upward toward the clavicle, being formed by the hypertrophied anterior fibers of the deltoideus. The boy is right-handed and suffers no disability.

Case 2. J. B., white, age eleven, was also seen during a school inspection. The sternal and abdominal heads of the right pectoralis major are missing and the costal portion is represented only by a hypertrophied slip from the second rib which forms a horizontal anterior axillary fold. This boy, too, is right-handed and experiences no disability. (Fig. 1).

Fig. 1

Absence of sternal and abdominal heads and partial absence of costal head of pectoralis major muscle.

*From the Department of Anatomy, Emory University School of Medicine, and Health Department of the City of Atlanta.

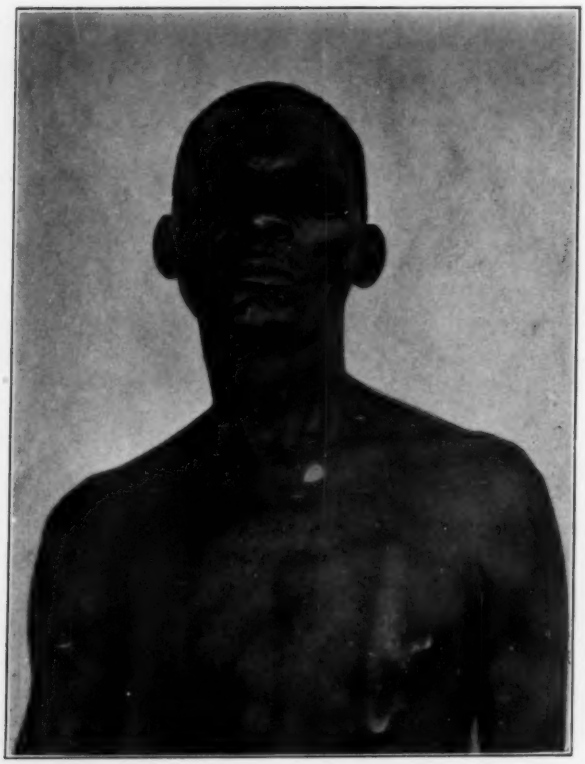

FIG. 2

Absence of pectoralis minor muscle detected at operation. The pectoralis major is normal and forms the usual anterior axillary fold.

CASE 3. M. M., colored, male laborer, age fifty-two, was operated upon by Dr. J. L. Campbell at Grady Hospital, Emory Division, September 29, 1924. The Halstead operation for carcinoma of the left breast was carried out, but the pectoralis minor could not be found during the procedure. A careful dissection of the removed tissue also failed to reveal any trace of the smaller muscle. As can be seen from the photograph (Fig. 2) the pectoralis major is normal in every way. The patient was right-handed but had never suspected any disability in his left arm or shoulder.

These cases have been presented because they are examples of a marked variation from the normal human anatomy which, on account of compensatory phenomena in surrounding structures, results in no appreciable disturbance of function. The third case is of particular interest on account of its rarity, no previously reported case having been found in the literature. The detection of the absence of the pectoralis minor by clinical observation is, of course, impossible in the presence of a normal and well developed pectoralis major.

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COMPLICATED TRAUMATIC DISLOCATION OF THE HIP

Report of Three Cases

BY ISADORE ZADEK, B.S., M.D., NEW YORK, N. Y.

Traumatic dislocation of the hip is a lesion of infrequent occurrence. According to Stimson, its frequency is about two per cent. of all traumatic dislocations.

One would think that the fixed attitude assumed in traumatic dislocation of the hip would be sufficient to at least call the attending physician's attention to the possibility of a lesion of the hip. Yet in these three cases the existence of a dislocation of the hip was not suspected, though one had occurred six weeks previously and the patient had been in a hospital for two weeks under observation immediately following the injury. The second injury had occurred nine weeks previously and the patient had been in a hospital for five weeks. The third patient was seen by the writer on the day following a severe automobile accident. Two of these dislocations were of the posterior variety and one an obturator dislocation.

Case 1. M. D., male, age twenty-six years.

The patient was injured Sunday, June 29, 1924, when the machine in which he was riding was struck by a train, in Cumberland, Maryland. Patient sustained a laceration just above the left eye and the left tibia was broken just below the knee joint. He was admitted to a local hospital. According to the patient's history, the leg was immobilized in a plaster-of-Paris bandage and this was changed on two occasions. The wound over the left eye was sutured. The patient was apparently unconscious following the accident. He remained in the hospital for two weeks.

When seen at home, August 4, 1924, patient was wearing a plaster-of-Paris knee bandage extending from the mid-thigh to the mid-leg with the knee in extension. This plaster was removed. It was evident from the attitude of the patient's left lower extremity which was flexed in adduction of about twenty-five degrees at the hip and marked inward rotation, that there was a lesion at the hip joint. The patient was not aware of any abnormal condition there. The greater trochanter was prominent and the head of the femur could be readily felt posteriorly, indicating a posterior traumatic dislocation of the left hip. The toes of the left foot were in contact with the ankle of the right foot as the patient lay in bed. No movement in the hip was permitted.

Measurements showed:

Anterior superior spine of the ilium to the internal malleolus—Right, 37¼ inches.

Anterior superior spine of the ilium to the internal malleolus—Left, 36¾ inches.

Umbilicus to the internal malleolus—Right, 42 inches.

Umbilicus to the internal malleolus—Left, 39½ inches.

Operation August 9, 1924. Under ether anaesthesia at the Hospital for Ruptured and Crippled, an attempt was made to reduce the dislocated hip, resorting with extreme force to the manipulations used in the reduction of congenital dislocations of the hip. The head of the femur could be mobilized but still could not be placed in the acetabulum.

FIG. 1

Case 1, M.D. Traumatic posterior dislocation of the left hip with fracture of the superior rim of the acetabulum before reduction. Injury six weeks previously.

FIG. 2

Case 1, M.D. X-ray examination made through plaster-of-Paris spica after closed reduction.

Traction was applied in the line of the thigh with the hip acutely flexed. Force was applied in the line of the femur in an attempt to force the head over the thin part of the acetabular rim. A wooden wedge was used as a fulcrum underneath the greater trochanter and extreme force was applied, abducting the thigh in an attempt to force the head forward, care being taken not to refracture the tibia. The head of the femur was eventually forced forward, resulting in an anterior dislocation corresponding with the anterior transposition as seen in congenital dislocation of the hips, except that the head was more prominent laterally than in a congenital dislocation of the hip. From this position the head of the femur was readily placed in the acetabulum and the shortening was overcome. All movements seemed free and the only abnormal sign noted was the marked prominence of the greater trochanter. Measurement from the anterior superior spine of the ilium to the internal malleolus on the right was a quarter of an inch more than on the left.

A plaster-of-Paris spica was applied, extending from the nipple level to the malleoli with the knee slightly flexed and the hip in twenty-five degrees of abduction.

September 21, 1924. Plaster was removed. Hip was in twenty-five degrees of abduction. Head of the femur was still in the acetabulum.

The patient, following his discharge from the hospital disappeared and could not be traced.

CASE 2. V. P., male, age forty-one years.

While at work, patient was struck by an automobile on September 3, 1927, and sustained a dislocation of the right hip for which he was admitted to a hospital in New York City where, according to his history, he remained for five weeks. X-ray examination was made soon after admission and patient was given an anaesthetic and a plaster-of-Paris spica was applied on this side. When discharged from the hospital after five weeks, the extremity was distorted, patient had pain, and was only able to navigate on crutches.

Physical Examination:

Patient was examined at the Hospital for Joint Diseases. General condition was good. Walked with a peculiar hop and jump on the right side, using crutches. The right hip was in forty degrees abduction and flexion to 130 degrees and in outward rotation of twenty degrees. The hip could be flexed further to ninety degrees, though further extension was not permitted. Slight rotation was permitted though no further abduction or adduction. There was lack of prominence of the greater trochanter.

Measurements showed:

Anterior superior spine of the ilium to the internal malleolus—Right, 33 inches.
Anterior superior spine of the ilium to the internal malleolus—Left, 34 inches.
Umbilicus to the internal malleolus—Right, 38½ inches.
Umbilicus to the internal malleolus—Left, 36¼ inches.
Right thigh eight inches above mid-patella, 14 inches.
Left thigh eight inches above mid-patella, 16 inches.
Right calf six inches below mid-patella, 11½ inches.
Left calf six inches below mid-patella, 11¼ inches.

X-ray examination showed an obturator dislocation of the right hip with considerable bone production, both above and below the head and neck of the femur.

Operation November 12, 1927. Through a Smith-Petersen incision the right hip was exposed. On coming down to the hip joint, the region of the greater trochanter was encountered instead of the head of the femur. With great difficulty the head of the femur was found below the acetabulum and displaced well inward and required about an hour of operative work to expose the head of the femur and an additional hour to dislodge it. There was considerable scar tissue surrounding the head and neck of the femur in this position. Finally a skid was passed over the edge of the head of the femur, and by flexing, adducting, and rotating outward the extremity, the head of the femur

FIG. 3

Case 2, V.P. Old unreduced obturator dislocation of the right hip, ten weeks old.

FIG. 4

Case 2, V.P. One month after open reduction and following removal of the plaster-of-Paris spica.

was displaced. The cartilage on the head of the femur was yellow and peeled off readily. It was somewhat irregular in outline and the acetabulum was found filled with granulation tissue. This was removed with a curette. It was now found impossible to place the head of the femur in the acetabulum because the superior portion of the capsule was so taut and was three-quarters of an inch in thickness. It was necessary to split this capsule across and then directly down to the superior border of the acetabulum. The deeper structures were closed with catgut and the skin was closed with silk. When the head of the femur was replaced, the structures were so taut that it was impossible to approximate the gluteal muscles in their proper position in several areas, because the greater trochanter was now about two inches further laterally than before the operation. A rubber tissue drain was placed in this large dead space and a plaster-of-Paris spica bandage applied extending from the toes to just below the level of the nipples with the hip in twenty degrees abduction and slight outward rotation, the knee flexed slightly and the foot at right angle.

FIG. 5

Case 2, V.P. Plate taken eighteen months after open reduction, showing marked osteo-arthritis. Head of the femur is in the acetabulum.

Toward the latter part of the operation, patient showed signs of shock. He was given about 900 cubic centimeters of salt solution with adrenalin intravenously and subpectorally. He was also given caffein sodium benzoate and reacted favorably. The blood was matched while he was still on the operating table. A blood transfusion of 500 cubic centimeters was given and patient's condition was soon satisfactory.

November 14, 1927. Drain was removed.

December 12, 1927. Plaster was removed. Wound was found completely healed. Patient had about fifteen degrees movement in all directions. Hip was in fifteen degrees abduction and slight outward rotation. Had fullness over the front of the hip joint.

Examination May 6, 1929. Patient was in excellent condition. His only real disability was that he was unable to lace his shoes. Walked with a slight limp on the right side. The right lower extremity was in slight outward rotation. Internal rotation

was permitted to the neutral position. The incision was nicely healed. The right hip was in the line of the trunk and in full extension; it could be flexed to 165 degrees; abducted to thirty degrees, and adducted to twenty degrees. The hip was stable. There was no elevation of the greater trochanter.

Measurements:

Anterior superior spine of the ilium to the internal malleolus—Right, 35 inches.
Anterior superior spine of the ilium to the internal malleolus—Left, 35 inches.
Umbilicus to the internal malleolus—Right, 37½ inches.
Umbilicus to the internal malleolus—Left, 38¼ inches.
Right thigh eight inches above mid-patella, 16⅝ inches.
Left thigh eight inches above mid-patella, 18½ inches.
Right calf six inches below mid-patella, 13¾ inches.
Left calf six inches below mid-patella, 13¾ inches.

He bent forward with the right side of the pelvis advanced. Movements of the lumbar spine were half normal.

CASE 3. J. S., female, age twenty-three years.

Complaint: Patient complained of pain in left thigh.

Patient was brought to the emergency room of the Mt. Vernon Hospital with a history of being in an automobile collision. She complained of marked pain in the left thigh and inability to move left lower extremity. Patient was in shock.

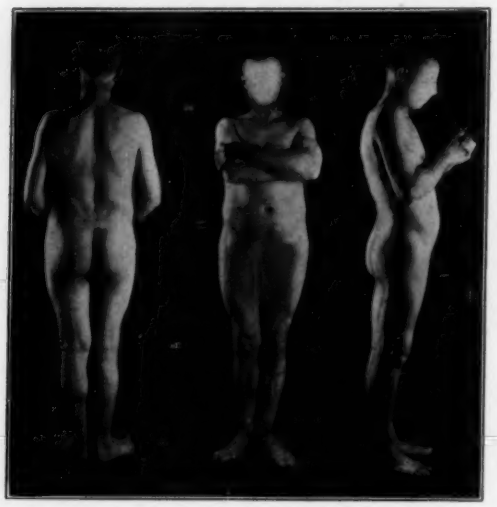

FIG. 6

Case 2, V.P. Photograph showing patient's posture eighteen months after open reduction.

Examination: November 20, 1928, the day after admission, showed:

Patient had a Thomas splint applied to the left lower extremity with adhesive skin traction. There was marked swelling of the left thigh and an obvious fracture near the mid-portion of the femur. The upper end of the lower fragment was palpable in the adductor region of the thigh just above the mid-portion. The lower end of the upper fragment was fixed in adduction. The pulse in the dorsalis pedis on the left was good. The tip of the trochanter on the left could not be felt because of swelling and the ring of the Thomas splint. X-ray examination of the left hip was requested, as x-ray examination of the shaft of the femur was made before the writer saw her.

Measurements:

Anterior superior spine of the ilium to the internal malleolus—Right, 31¾ inches.
Anterior superior spine of the ilium to the internal malleolus—Left, 31¾ inches.

X-ray examination before operation showed:

A posterior dislocation of the hip with a fracture through the head of the femur, about one fourth of the head of the femur being broken off the lower quadrant and remaining in the acetabulum.

A comminuted fracture of the shaft of the same femur with considerable displacement and slight overriding.

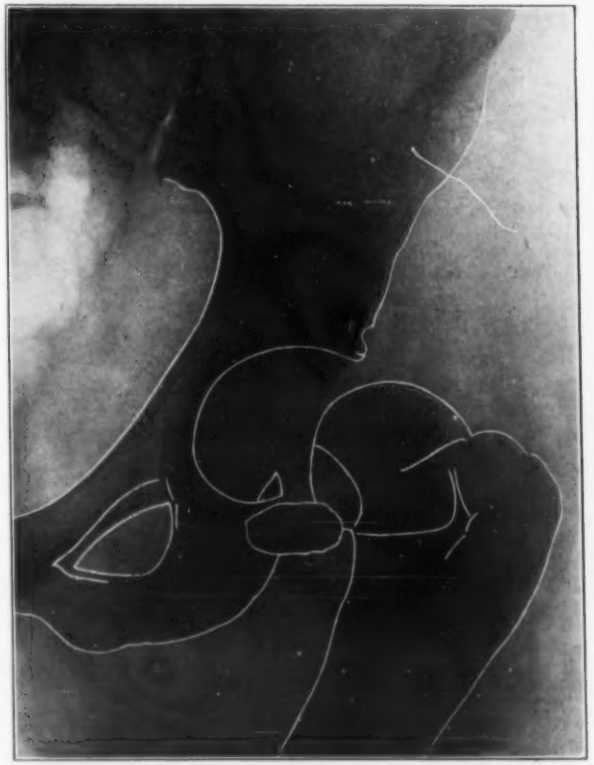

FIG. 7

Case 3, J.S. Showing dislocation of the head of the femur with fracture of the head of the femur.

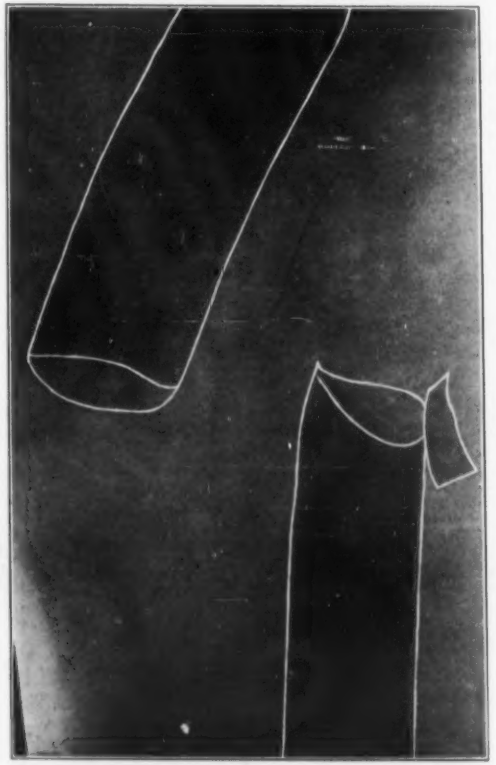

FIG. 8

Case 3, J.S. First x-ray examination showing fracture of the shaft of the femur. Anteroposterior view, taken at time of injury.

FIG. 9

Case 3, J.S. X-ray examination showing fracture of the shaft of the femur. Lateral view, taken at the time of injury.

The problem presented was a very interesting one. After due consideration it was decided to perform an open operation on the dislocated hip and to insert a Steinmann pin through the lower end of the femur.

Operation November 22, 1928:

A curved incision was made from the anterior superior spine of the ilium encircling the base of the greater trochanter. Fascia lata was split in the line of the skin incision, exposure was made between the tensor fasciae femoris and the gluteus medius. Fascia lata was found ruptured. The greater trochanter was removed at its base, in line with the superior border of the neck, with muscles attached and reflected upward. The capsule was found torn posteriorly and the head of the femur presented immediately. The fragment torn from the head of the femur was found in the acetabulum It could be reached with difficulty by the examining finger. Instead of removing this fragment immediately, the head of the femur was placed in the acetabulum and it was found that the fragment fell into proper position. A drain was placed down to the capsule. The greater trochanter was sewed back with chromic gut. Subcutaneous catgut sutures were inserted and skin was closed with continuous silk. A Steinmann nail was inserted next just above the femoral condyles through one-inch incision on either side of the shaft. Patient was returned to bed and twenty pounds traction applied. This was later reduced to fifteen pounds.

FIG. 10

Case 3, J.S. Showing the appearance of the hip joint and the firmly united shaft of the femur six months after injury. The fracture of the inferior portion of the head of the femur is still evident, as is the operative line of osteotomy of the base of the greater trochanter.

Blood Examination November 19, 1928:

Leucocytes ..... 24,000 per cubic millimeters

Differential leucocyte count:

Polymorphonuclear neutrophils ..... 83 per cent.
Small lymphocytes ..... 15 per cent.
Large lymphocytes ..... 2 per cent.
Hemoglobin ..... 60 per cent. Color index 8

November 26, 1928. Rubber tissue drain removed. No exudate. Wound dry.

January 1, 1929. Steinmann pin was removed. No unusual reaction found around pin site. Bony prominence found on medial aspect of thigh at site of fracture. General alignment of the extremity was fair. Measurements of the lower extremities from the anterior superior spines of the ilia to the internal malleoli were equal on the two sides,—*i.e.*, 32¼ inches. There was slight internal rotation of the femur as compared with that of the opposite side. Union at site of fracture was progressing nicely, but was not complete. Abduction of the left hip was readily executed to thirty-five degrees. Lumbar lordosis was slightly increased but no fixed flexion deformity of the left hip was present. Rotation of the left hip was one quarter normal. Flexion of the left hip was permitted to 125 degrees. Adduction was free. Twenty-five degrees movement was permitted in the left knee from 180 to 155 degrees. Operative incision over left hip found nicely healed. Patient was fitted with a walking caliper splint with a ring joint at the knee and a leather cuff for the thigh.

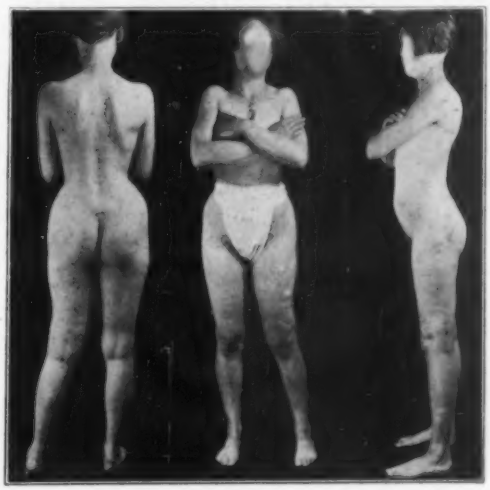

FIG. 11

Case 3, J.S. Showing posture six months after injury.

Examination three months later:

Patient was in good condition. She walked without apparatus and with a slight limp on the left side. Left hip was in ten degrees of abduction, and full extension. Flexion was permitted to 140 degrees and no further adduction or abduction was permitted. Rotation was one half normal. No reaction around operative incision.

Measurements:

Anterior superior spine of the ilium to the internal malleolus—Right, 32½ inches.
Anterior superior spine of the ilium to the internal malleolus—Left, 32¼ inches.
Umbilicus to the internal malleolus—Right, 36 inches.
Umbilicus to the internal malleolus—Left, 36¾ inches.

Left knee could be flexed to sixty degrees. Slight drainage about points of egress of Steinmann pin. General alignment of shaft of femur was excellent.

SUMMARY AND CONCLUSIONS

1. Although traumatic dislocation of the hip is an infrequent lesion, its presence should be suspected when the hip is held fixed in a distorted attitude following a severe injury.

2. Three cases of traumatic dislocation of the hip are reported. One was first seen by the writer six weeks after the injury; the second, nine weeks after the injury, and the third case on the day after the injury. The third case was complicated by a fracture of the shaft of the femur as well as a fracture of the head of the femur. The injury to the shaft of the bone completely overshadowed the hip lesion which had not been recognized.

3. It is possible to reduce these old dislocations weeks after their occurrence. One of these of the posterior variety was reduced by the closed method six weeks after the injury. Another (obturator) was reduced by open operation ten weeks after its occurrence.

4. The ages of these patients were in the twentieth to fortieth year limit, which as Baetjer has observed, is roughly the common age incidence. At an earlier and later period, fracture of the neck of the femur is most likely to occur.

5. Two of these patients were male and the other female.

6. These cases should be recognized earlier as the result of reduction of the old cases compares most unfavorably with the recent ones, particularly because of the subsequent occurrence of an osteo-arthritis.

7. The blood count in one patient is included as it illustrates the fact that a patient with considerable hemorrhage into the tissues, may show a leucocytosis and an increase in polymorphonuclear leucocytes from this source alone without additional complications.

A NEW METHOD OF UTILIZING TRACTION IN THE TREATMENT OF FLEXION DEFORMITY OF THE HIP IN HIP DISEASE

BY SAMUEL S. HANFLIG, M.D., BOSTON, MASS.

From the Department of Surgery, Yale University, School of Medicine, New Haven, Conn.

Flexion deformity is a universal and invariable symptom of hip joint disease. Its treatment, be it a single or a series of successive methods, must correct the existing deformity and immobilize the hip joint for relief from muscle spasm and resulting contractures.

Traction has been used extensively for the treatment of flexion deformity in hip disease and for its application and utilization we present the apparatus illustrated in Figures 1 and 2. We present it for several reasons: It is comfortable and easy to apply. It permits traction in the line of deformity and enables one to perform the Thomas flexion test without disengaging any of the apparatus. It permits immediate and secure changes in the direction of traction.

It consists of a center pulley (*A*) which is a screw pulley, screwed into a small block of wood. The block of wood has a drilled hole in its sides for a rope to pass through. This rope passes up and over pulleys (*B*) and is secured to the sides of the Balkan frame, after pulley (*A*) has been placed in the desired position. Bar (*C*) inserts between pulley (*A*) and the sides of the Balkan frame. It is kept in position by the pull of weight (*W*), opposed by the pull of the patient's leg, against the sides of the Balkan frame. It serves to prevent pulley (*A*) from being pulled towards the head of the bed. As the extremity is pulled upon, it is suspended and counterbalanced by ropes passing up and backwards to the head of the bed, where they are pulled upon by weights heavy enough to keep the leg suspended in whatever position it is placed.

The patient is placed in bed, and skin traction adhesive and bandaging are applied to the affected extremity. The Thomas test is applied to determine the exact degree of deformity. Once the extent of the deformity is ascertained, pulley (*A*) is fixed so that the pull is in the direct line of deformity. This is done by changing the position of the ropes running through pulleys (*B*) and changing the level of bar (*C*). Traction is applied as shown in illustrations. The weight employed varies with the degree of spasm, the weight of the patient, etc. Its exact amount is a matter with which one soon becomes familiar. Traction is continued in this direction for several days. Then the pull of the traction is released, the Thomas test reapplied and the affected leg allowed to fall into its new and improved

line of deformity. The pulley arrangement described above permits immediate adjustment of the line of traction.

If the original deformity is flexion and abduction, the center pulley (*A*) is gradually moved down and towards the other leg. If it is flexion and adduction, it is gradually moved down and away from the other leg.

When the acute stage has subsided and the deformity has been corrected, this treatment may be followed by weight-bearing in a protective splint with careful watch for a return of symptoms and increasing deformity.

The following case is presented to illustrate the use of the apparatus suggested:

FIG. 1

H. B., age three and one-half years, was admitted on May 18, 1928, with a chief complaint of fever, loss of weight, and inability to move the left hip. His family and past history was negative. The present illness dated back to a coryza and nasopharyngitis occurring twelve weeks prior to admission. Following recovery from this, the patient was well up until six weeks prior to admission. At this time he developed an acute tonsillitis associated with high fever, delirium, and an adenitis at the left angle of the jaw. Four weeks prior to admission, the right hip became acutely flexed and abducted and motion in it was extremely painful. An anterolateral swelling developed on the upper thigh and was incised with the release of about a cup of pus. Bacteriological examination of the pus was not made. This was followed by immediate relief with subsequent complete restoration of function. Shortly thereafter the left hip became similarly involved.

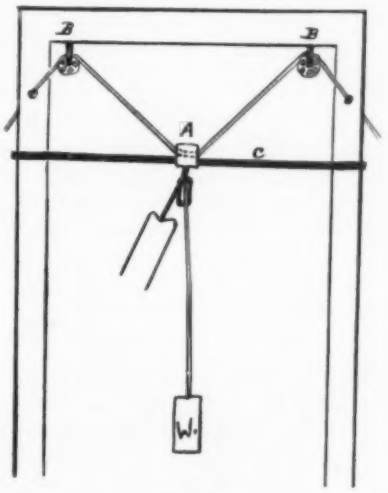

FIG. 2

At admission the child was declared to be the most marked example of malnutrition seen on the service. Physical examination revealed large red tonsils, chronic adenitis of the left tonsillar glands, and an acute flexion deformity of the left thigh associated with a slight amount of abduction. Any attempted motion was extremely painful. Admission diagnosis was:

1. Sepsis—multiple focal abscesses.
2. Infectious epiphysitis ? —Tuberculosis?
3. Hypertrophied tonsils.
4. Malnutrition and anaemia.

Complete x-ray examination of the child revealed changes only at both hips. The epiphyseal changes suggested a bilateral epiphysitis, the exact nature of which one could not be certain of. After a transfusion of 200 cubic centimeters of citrated blood, skin traction, with a pull of five pounds, was applied to the extremity as described above, in the line of deformity. The deformity was about ninety degrees flexion, with a slight degree of abduction. Pain and spasm disappeared early, and the direction of pull was changed every few days, guided by the Thomas test as the deformity improved. On June 22, 1928, one month after admission, the flexion deformity had decreased to about twenty degrees. A cast was then applied as a spica to protect the child during the tonsillectomy which was performed on June 30.

The cast remained on until July 14, at which time the flexion deformity had been entirely corrected. A new cast was applied on this date with the leg in full extension and slight abduction, and at a midpoint between internal and external rotation. This second spica was removed on August 2, and the patient was allowed to be loose in bed with sandbags on each side of the leg for the first few days. Because of pain on motion another cast was applied on August 28. This was removed late in October, and the child was discharged on November 28, 1928, at which time his only disability was a slight waddling gait with some limitation of motion in the right hip.

X-ray pictures were taken frequently. On June 18, x-ray showed a softening of the head of the femur with some loss of joint space. On July 30, it showed moderate destruction of the head of the femur, with some loss of joint space, suggesting a possible ankylosis. One month later, on August 22, x-ray showed thinning and flattening of

the epiphysis of the left femur, widening of the neck of the femur, partial absorption of the interarticular cartilages, and slight deepening of the acetabulum. At this time the possibility of a Legg-Perthes' disease was strongly considered.

He returned at intervals for several months for physiotherapy and heliotherapy. He was last seen in the spring of 1929, at which time there was normal motion at the hip joint. A diagnosis of tuberculosis was therefore not tenable. The diagnosis of acute epiphysitis was probably also not tenable, because of the return of complete motion to the hip. The most likely diagnosis was a very severe Legg-Perthes' disease on which was probably superimposed an acute extra-articular infection. Whether or not in view of this diagnosis, normal action in the hip joint could have been expected to return without the use of traction is questionable. In view of the severity and acuteness of the condition, normal motion probably would not have returned without adequate treatment. At least, the case serves to present the features and application of the apparatus proposed.

CONCLUSION

An apparatus is presented for applying traction in flexion deformity of the hip, in hip disease. A case is described showing its application. We believe it is a desirable and improved way of utilizing traction because of the following features: It is easy to apply, comfortable to the patient, allows a pull in the direction of deformity, and permits immediate secure changes in the direction of pull as the deformity improves. It enables one to perform the Thomas test repeatedly without particularly disturbing the apparatus.

CRUTCH ATTACHMENT FOR USE IN CASES OF PARALYSIS OF THE TRICEPS MUSCLE

BY FRANK R. OBER, M.D., BOSTON

Patients who are paralyzed from the waist down can walk if they have two good hands and one good arm. Many patients have loss of power in the triceps only. As this muscle is one of the most important crutch-walking muscles, and one on which a person depends for lifting power, when it is paralyzed walking is more difficult.

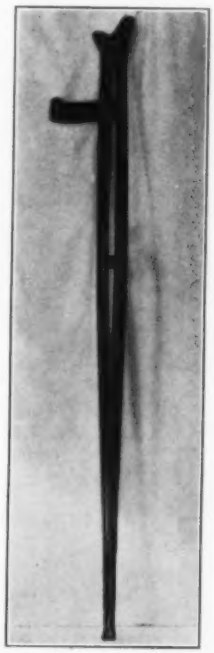

FIG. 1

Side view of triceps band.

FIG. 2

Side view of triceps band with the patient standing.

Several crutch attachments to assist extensor function of the arms have been used, but most of them completely encircle the arm, which makes it difficult to get rid of the crutch in case of a fall. The appended photographs illustrate a simple steel device about three and one-half inches long by one inch wide covered with leather and thin felt and slightly curved posteriorly. This may be riveted to the crutch just at or above the olecranon process, and will hold the arm in a semi-rigid manner, provided there is enough power in the hand to grasp the crutch handle.

THE SHOULDER SPICA
A SIMPLE METHOD OF APPLICATION

BY L. C. CHU, M.D., PEIPING, CHINA

The Department of Surgery, Peiping Union Medical College

While some apparatus is indispensable in orthopaedic work, it is desirable not to crowd the operating room with appliances seldom used or perhaps unnecessary. The application of a plaster shoulder spica to a

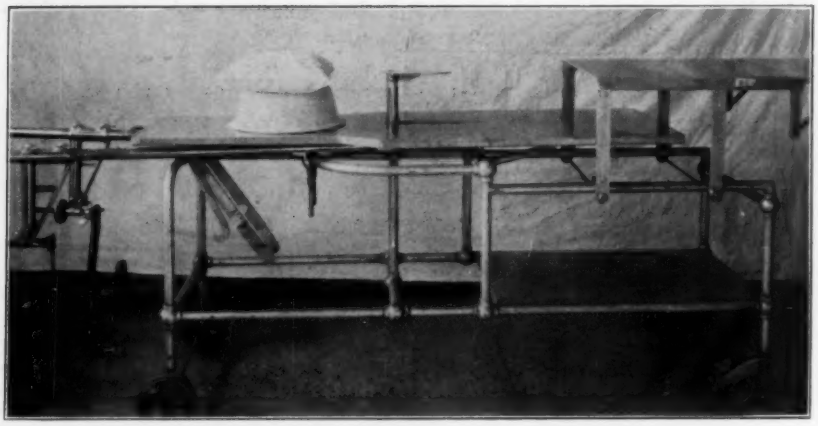

FIG. 1

Hawley's table with the lower piece of table top dropped, sacral plate of proper size applied on the shaft, and a small pillow on the inverted wash basin.

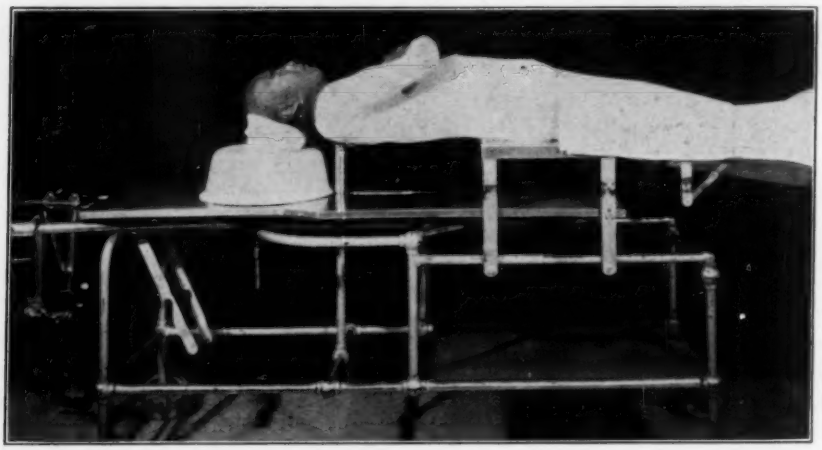

FIG. 2

The patient has been turned around from his original head end to foot end of the table. He is now placed with his head resting on the pillow, his upper dorsal region on the sacral plate, and his pelvis and lower limbs on the upper part of the table top.

FIG. 3

This is to show the actual application of the plaster cast with patient in the same position as shown in Fig. 2.

patient under general anaesthesia is, however, tiresome to the assistant who supports the patient's back and difficult for everyone concerned, if no fixed mechanical support is employed. In the issue of *The Journal of Bone and Joint Surgery* for October 1929 (XI, 776), the writer was much interested in the new apparatus described by Dr. A. P. MacKinnon for the application of a plaster shoulder spica to an anaesthetized patient, which seems admirably suited for its purpose; but in our orthopaedic clinic a special apparatus of this kind is found to be unnecessary.

FIG. 4

After the application of the plaster cast, patient is moved on to a stretcher. It is to be noted that the sacral plate has been lifted off the shaft but left in situ. It is now ready for removal.

We simply use the Hawley table which is ordinarily found in every orthopaedic clinic, drop the lower part of the table top, apply the sacral plate, and put a small pillow on an inverted wash basin (Fig. 1). When this has been done, the patient is turned around and placed with his head resting on the pillow, his upper dorsal region on the sacral plate, and his pelvis and lower extremities on the upper part of the table top (Fig. 2). During the application of the plaster cast an assistant holds the affected arm in the desired position, while a nurse keeps the other arm out of the way (Fig. 3). Since there is nothing in the way, the anaesthetist has free access to the patient's head to administer the anaesthetic or perform any other necessary measures. For children it goes without saying that a small sacral plate is used.

After the application of the plaster cast, the sacral plate can be removed, either by shifting the patient's whole body downward or by lifting the patient and plate off the shaft and pulling the plate out afterwards (Fig. 4). We have found this method, which obviates the necessity of an extra piece of apparatus in the operating room, to be simple and satisfactory in all cases in which we have used it. The method may have been described before, but since we have found no such record, it has seemed desirable to report it.

DEVICE FOR OVERCOMING NON-BONY FLEXION CONTRACTURES OF THE KNEE*

BY EDWARD KIMMEL CRAVENER, M.D., CLIFTON SPRINGS, NEW YORK

The purpose of this paper is to present a mechanical device for overcoming posterior capsular shortening and fibrous adhesions across the joint surfaces, which result in flexion contractures. Manifestly, this device will not help where true bony union has occurred. This device is offered to the medical profession with the hope that it does not merely swell a list of already discarded apparatus for this disorder. It has been used in the author's experience in sixteen cases with good results in all.

The principle is that a leg can be extended on the knee by simple extension or that, if the leg is fixed, extension of the thigh will produce the same results. In this device both of these principles are utilized. The device, in short, consists of levers *A* and *Z*, interlocked at a common point, *C*, with a cam. By elevation of the lever *A*, on which the leg rests, the lever *Z* is depressed and with it the thigh is depressed or extended. This constitutes the underlying principle. The motive power is supplied by

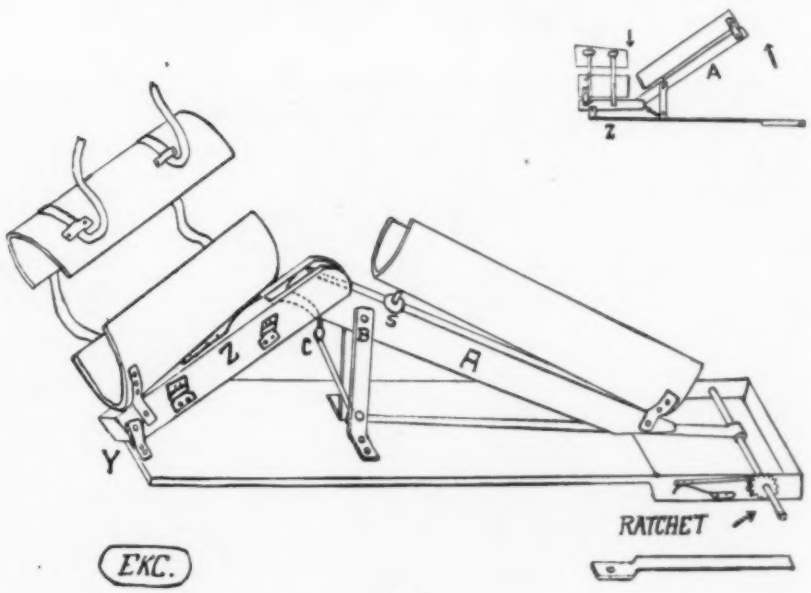

FIG. 1
Device in Diagram.

*Apparatus developed by the author while on the Orthopaedic Service at the Children's Hospital, Boston.

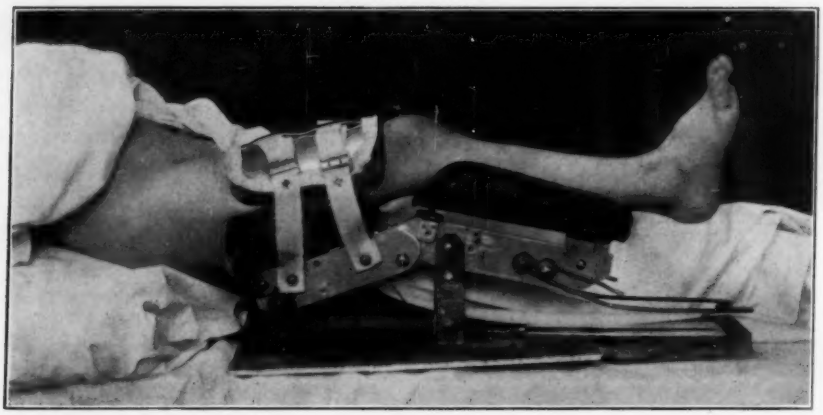

FIG. 2
Stretcher flexed.

tape attached to a ratchet which tightens this tape, thus elevating the leg and depressing the thigh.

Accompanying illustrations show the device. In Figure 1 the device is shown in diagram. In Figures 2 and 3 the device is shown on the patient.

Conclusions. In sixteen cases in adults and children the author has been successful in reducing flexion deformities of the knees, non-bony in type, usually within three weeks.

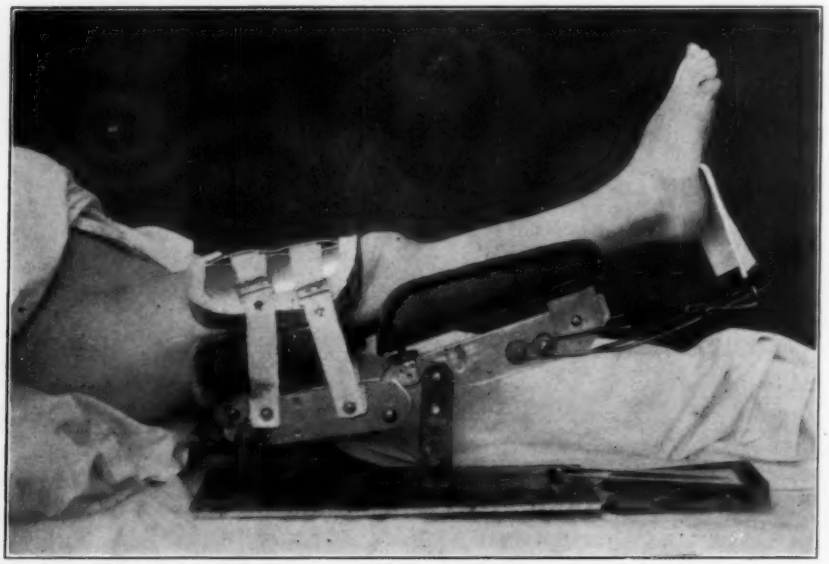

FIG. 3

Stretcher extended. This cut does not show the tibial head as well supported as is customary now, with a longer thumb screw *S*.

The author believes, therefore, that this apparatus is efficient, since all possible methods of extending a leg are incorporated in this device, except skin traction, which can be added—but so far has not been necessary.

He further believes that it has some virtue in that the tibial head is constantly supported upon the trough of *A*, and subluxation of the tibia, which can occur with skin traction or pillows, is here eliminated.

Against this device there is the possibility of ischaemic slough under the anterior thigh pad. This has not occurred recently in our experience; in fact, it has occurred only once and that in a case in which we were too enthusiastic in obtaining rapid extension.

The device as manufactured by the Charitable Surgical Appliance Shop of Children's Hospital, Boston, Mass., is comparatively inexpensive. If desired it can be constructed of wood by any mechanic.

SPLINT FOR CORRECTION OF CLAW-HAND

BY JULIUS S. NEVIASER, M.D., NEW YORK, N. Y.

House Surgeon, Hospital for Joint Diseases

Not infrequently the orthopaedic surgeon encounters the so called claw-hand, in which the wrist is fixed in palmar flexion, the metacarpophalangeal joints are in hyperextension, and the fingers at the interphalangeal joints are in flexion.

This type of claw-hand often results from either a Volkmann's ischaemic paralysis, from lesions of the ulnar and median nerves quite low in the forearm, or follows inflammatory conditions of the fingers and hand which have extended along the tendon sheaths and fascial spaces.

The conservative treatment of this type of hand has found favor with a majority of the orthopaedic surgeons. Passive manipulation under anaesthesia has often succeeded in breaking up adhesions and fibrous tissue around the contracted joints, but the trauma to the tissues may be followed by small hemorrhages in and around the joints, with the result that new adhesions form and nothing is gained by manipulation.

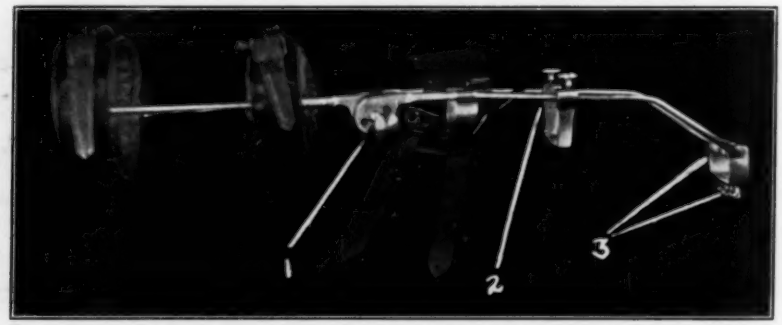

FIG. 1

Fig. 1-A. Wrist in neutral position.

Fig. 1-B. Wrist in flexion.

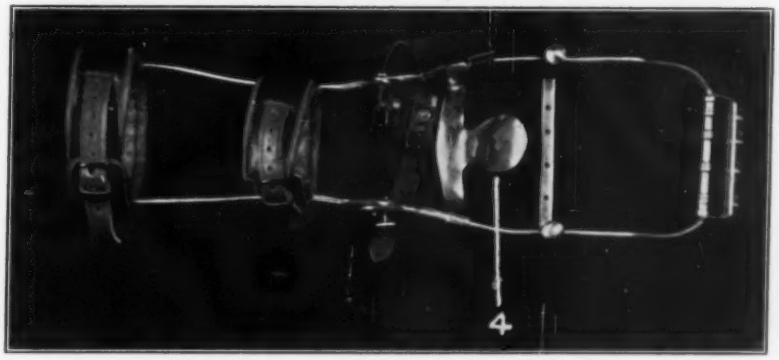

Fig. 1-C. Splint viewed from above.

Shows three views of splint.

1. Graduated lock joint which allows various positions of the wrist.
2. Sliding cross bar where downward traction can be made on the hyperextended metacarpophalangeal joints.
3. Two-plane attachment where traction may be made in the line of the deformity.
4. Metal piece for the palm.

It is generally accepted that the best form of conservative treatment is by the use of splints. Various forms of splints have been used, many with some excellent results. But in rather severe cases, many of the splints have failed to serve their purpose, especially in overcoming the hyperextension of the metacarpophalangeal joints. This fact led the writer to devise a type of splint which will not only correct the contractures in the mild type of claw-hand but also in the severe form.

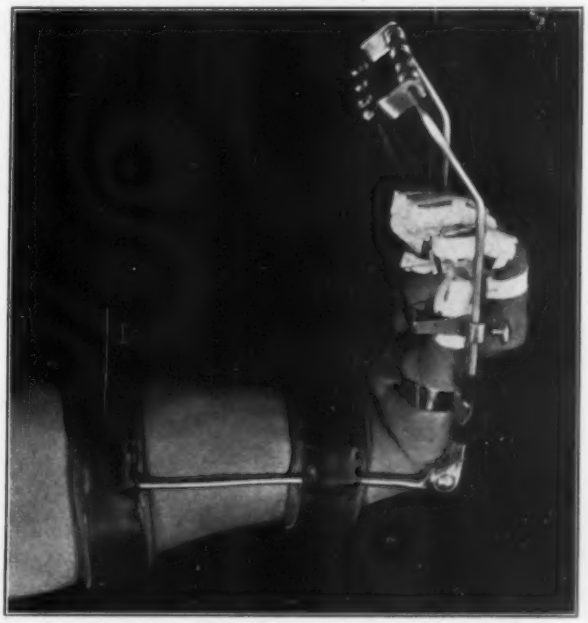

FIG. 2
Splint applied to a claw-hand before correction.

This apparatus is in the form of a banjo splint (Fig. 1-A), with a lock joint at the wrist (*1*) to allow the flexed, neutral or extended position. There is a sliding cross bar (*2*) on the banjo part of the splint to permit

Fig. 3-A

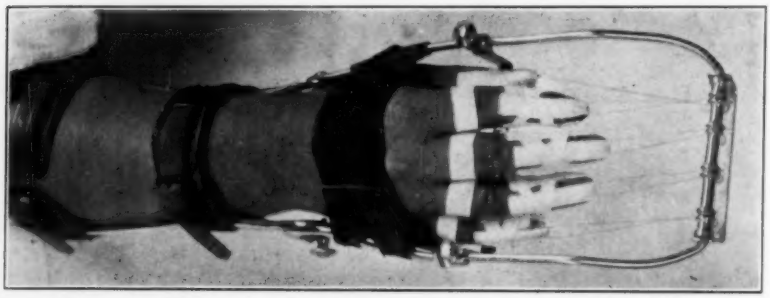

Fig. 3-B

FIG. 3
Position in splint after correction of the deformity.

traction on the metacarpophalangeal joints. The metal piece for the palm (*4*, Fig. 1-C) serves two purposes,—one to maintain the palmar arch, and the other to hold the heads of the metacarpals fixed while the traction is made on the joints themselves by pull on the proximal phalanges. The end of the splint has a two-plane attachment (*3*) for fixation of the traction cords in the line of the deformity.

One begins the traction by applying the splint with the wrist flexed. This releases the tension on the contracted fingers. Adhesive strips are applied up to the proximal interphalangeal joints. The traction cords are passed through the adhesive strips at the ends of the fingers. They may consist of small steels, catgut, or narrow tape. Adhesive strappings are then applied over the proximal phalanges to obtain downward traction and thus overcome the hyperextension of the metacarpophalangeal joints.

Traction is then applied in the line of the deformity by running the traction cords to the lower bar of the two-plane attachment. The traction is tightened and changed to a straighter line by running the traction cords to the upper bar of the two-plane attachment as the fingers are gradually

straightened. Following this correction, the wrist is brought up to a cock-up position by means of the graduated lock joint at the wrist.

During the course of this traction, the traction cords may be loosened daily to allow for massage and exercises which are essential adjuncts to the treatment.

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JONES, SIR ROBERT: Orthopaedic Surgery of Injuries. London, Oxford Medical Publications, 1921.

FRACTURE HARNESS

BY E. T. HIER, KANSAS CITY, KANSAS

Orderly, Bell Memorial Hospital

In using the Hodgens' splints with traction, difficulty is encountered in keeping the patient in position in bed, so that the traction may hold the bones in alignment.

It is difficult to make a suitable harness, which does not bruise the tissues nor cause any discomfort to the patient, and yet allows him movement for exercise. The old methods all accomplish the purpose of keeping the patient up in bed, but the comfort of the patient is made secondary.

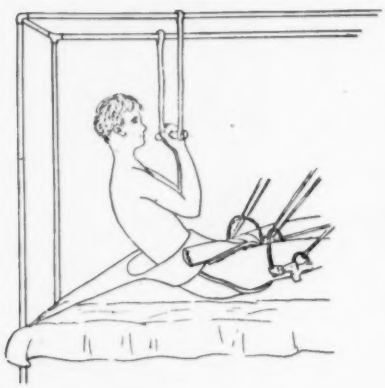

FIG. 1

A new traction harness called the H. B–M Harness has been designed. Although there are very few new principles introduced, it embodies the desirable features of the present methods. The design is simple and a complete harness can be constructed in an hour's time. It does not interfere with any of the natural functions of the body, and once it has been put on the patient, it need not be removed for weeks. It permits the patient to sit upright in bed or swing from side to side. He may even raise his entire body off the bed by means of a trapeze, thus exercising his trunk and upper extremities.

Referring to the diagrams: Strips *A* and *B* are sewed to portion *F* and when they are fastened to the head of the bed the harness holds the patient up in bed. Strip *C*, or the belt, is sewed to the other end of portion *F* and is laced around the abdomen. It may even be unlaced and the harness will hold. This permits the patient to be thoroughly bathed or a hot water bottle applied to the abdomen, if necessary. The belt is padded in the sacral region to prevent pressure soreness and to allow the maximum comfort on a bedpan. The strips *E* and *D* are lined with heavy harness felt and are sewed to belt *C* which holds them apart so that they do not wrinkle or become soiled.

By means of this harness the patient is kept from sliding to the foot of the bed and is allowed a maximum amount of freedom. It also permits the bed clothing to be changed without a single adjustment of the harness.

The patient on whom this harness has been used for over ten weeks is a man forty-three years of age and weighs 155 pounds. There are not any

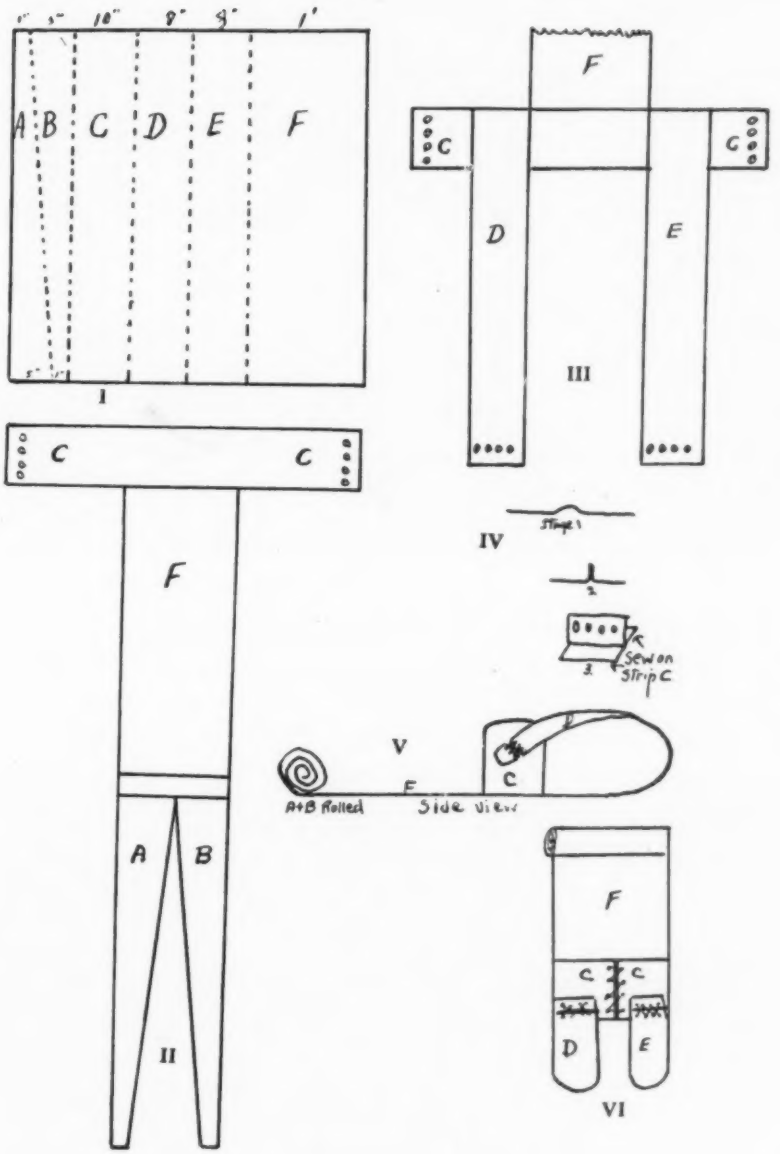

FIG. 2

H. B-M traction harness.

Material used: canvas and harness felt.

Where the material overlaps, that portion is sewed carefully.

Eyelets are sewed well.

Harness felt is sewed on strips *D* and *E*.

IV shows attachment that fits on strip *C* to lace strips *D* and *E*.

Thin felt or flannel covers the whole strip *C*, ends of *D* and *E*, and base of *F*.

V. Side view.

VI. Top view.

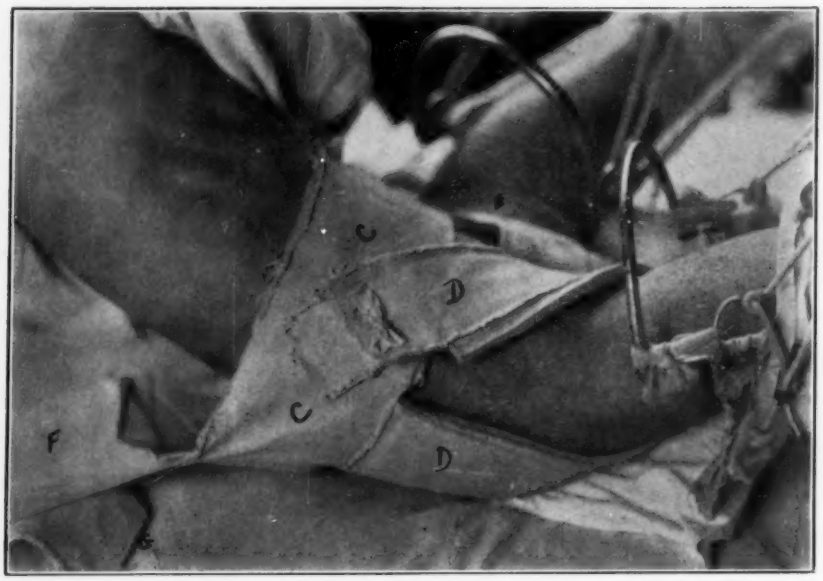

FIG. 3

Shows side view of harness. *C*, the belt encircling abdomen; *D* and *E*, padded strips; *F*, the flat strip which extends up the back and is made fast to the head of the bed by means of strips *A* and *B* of diagram; *G*, another adjustment for small patients. The patient is sitting almost straight up in bed.

FIG. 4

Showing the harness from an elevated position at the head. Showing the general scheme of arrangement.

signs of the tissues being bruised; he sleeps well at night; and he says that he has never had any discomfort due to the harness.

SUMMARY

The advantages of the device are:

1. It keeps the patient up in bed.
2. It allows the patient freedom of movement from the hips up.
3. It gives the patient a maximum amount of comfort.
4. It does not bruise the tissues.
5. It allows the natural functions of the body to be carried on.
6. It is inexpensive, costing not over $1.50.

KONRAD BIESALSKI

In the sudden death of Konrad Biesalski on January 28, the orthopaedic world has lost one of its most redoubtable champions. Born sixty-one years ago in Osterode, a small town of East Prussia, his rise to eminence from this humble beginning suggests more of the tempo of our western civilization than the slower rhythm of the Old World. At school he was given a thorough classical education. This stood him in good stead throughout his life, for his was a nature not satisfied by narrow utilitarian needs but constantly in search of the wisdom and beauty and humor of a broad culture. Graduating as Doctor of Medicine in 1894, he served as assistant under a renowned surgeon, Prof. Werner Koerte, and also under the pediatrician, Heubner. Then as his interest in orthopaedic surgery developed, he worked for a number of years in Hoffa's clinic. When he was a little more than thirty years old, he conceived the first of those orthopaedic dreams which his enthusiastic and resolute persistence transformed into actualities. He was convinced that the existing provisions for the care of crippled children in Germany were woefully deficient, but how could this fact be conclusively proven? How else than by a complete census of all the crippled children of Germany and a comparison of these figures with the number of available hospital beds. Undaunted by the immensity of this undertaking, Biesalski in 1903 was able to persuade Prof. Dietrich of the Prussian "Kultusministerium" of the wisdom of the plan and soon Biesalski's census cards were to be found in every hamlet of Germany. With the aid of Germany's trained officials he completed the task by 1909. The impressive volume containing his report represents the only accurate complete register of all the crippled children of a single country which has thus far been tabulated. The total figure came to 100,000 and for these there were only 3,000 beds.

Biesalski's census brought immediate practical results. A society, the German Association for the Care of Cripples, was established and the number of institutions for crippled children increased with a bound.

Despite the arduous details of the census, Biesalski found time to realize another orthopaedic dream. In 1905 he had organized a society for the care of crippled children of Berlin and Province of Brandenberg. A tiny clinic with eight beds had been started; after a year the city of Berlin had loaned him a larger building with room for 150 crippled children. At its opening Oscar Pintsch and his wife Helene, fired by Biesalski's enthusiasm, gave him a fund of 500,000 marks for the erection of a permanent crippled children's home. This institution, fittingly called the "Oscar Helene-Heim", situated in a large wooded tract near Berlin, was finished in 1913. With its 300 beds, school, workshops, research laboratories and unique orthopaedic museum, it stands today as Biesalski's greatest monument, a center for the study and development of the care of cripples.

At the outbreak of the War, Biesalski realized at once that suitable provision had to be made for the crippled soldiers. On his own initiative, long before the Government had acted, he visited all the important centers of Germany and drafted plans for increasing the existing facilities for the care of cripples, so as to place these institutions at the service of the Army Medical Department. To educate the public he wrote in 1915 a monograph entitled "The Care of War Cripples". In this he stressed not only the scope of modern orthopaedic methods of treatment, but the importance of curative workshops for restoring the morale of the crippled soldier and remaking him into a wage-earner. It is impossible to estimate the effect of circulating 150,000 copies of this pamphlet; for the first time not only the layman but the physician suddenly realized what the term "orthopaedic surgery" signified.

At the conclusion of the War Biesalski, not content with having done more than any other to rehabilitate the war cripple, insisted on his right to reenter industry. He

KONRAD BIESALSKI

was largely responsible for the German "Kriegs-krüppelfürsorge Gesetz" (law for care of war cripples) of May 1923, which made it obligatory that every industrial organization having fifty or more employees, employ at least one crippled war veteran for every fifty able-bodied workers. Thanks to this provision, of the 350,000 war cripples, it is estimated that more than 250,000 are in gainful employment.

Biesalski was for many years Editor-in-chief of the "*Zeitschrift für Orthopädische Chirurge*" and of the "*Zeitschrift für Krüppelfürsorge*". He was elected President of the German Orthopaedic Association; he was an Honorary Member of the Swedish and Italian Orthopaedic Societies. His scientific publications are numbered by the hundred. He was the first to suggest the use of the tendon sheath as a pathway for a transplanted tendon and with his coworker, Mayer, he elaborated the details of the "Physiological Method of Tendon Transplantation".

Biesalski was a man of vision, a leader, a great orator, a master of literary style. To converse with him was an unforgettable joy; to work with him a privilege. As a chief he allowed his assistants the freest scope; he encouraged initiative and stressed the development of original ideas. The consequence has been a flood of scientific papers from the Oscar Helene-Heim. When an idea came to him he could not rest until he had carried it out. Like so many gifted men whose spirits are stronger than their bodies, he frequently overworked, and then would come a period of depression closely resembling those from which Abraham Lincoln suffered. To fight down this tendency was Biesalski's hardest battle. He had a gift for friendship and took a deep pleasure in human contacts. His warm impulsive nature tended to swing him readily to extremes; he could thunder invective as well as utter honeyed words of praise. More than any man I have ever known intimately, he was a genius.

To orthopaedic surgery his death is an irreparable loss "and leaves a lonesome place against the sky".

News Notes

The Forty-Fourth Annual Meeting of The American Orthopaedic Association will be held June 18 to 21, 1930. On the eighteenth there will be a Clinical Day in Boston, when the various hospitals doing orthopaedic work will be visited. The headquarters of the meeting for that day will be at the Hotel Statler. On the nineteenth the Association will go to the Sanatorium at Lakeville, a State Hospital for surgical tuberculosis. The day will be spent at that hospital. There will be an exhibition of cases, opportunity for discussion, an inspection of the hospital, and the first scientific session. In the late afternoon the party will go to Cape Cod, where two days will be devoted to the presentation of scientific papers, and to recreation.

The Preliminary Program, arranged by the Program Committee, Dr. Philip Wilson, Chairman, is as follows:

BOSTON, WEDNESDAY, JUNE 18

Clinical Demonstrations

9.00–10.00 A.M.	Massachusetts General Hospital	Dr. M. N. Smith-Petersen and Associates.
10.30–11.30 A.M.	Children's Hospital	Dr. R. B. Osgood and Associates.
12.00– 1.00 P.M.	Robert Brigham Hospital	Dr. L. T. Swaim, Dr. P. D. Wilson, and Associates.
1.00– 2.00 P.M.	Luncheon	
2.30– 3.30 P.M.	Carney Hospital	Dr. W. R. MacAusland and Associates.
4.00– 5.00 P.M.	Boston City Hospital	Dr. F. J. Cotton and Associates.

Transportation between the hospitals will be provided for members and guests.

LAKEVILLE STATE SANATORIUM, THURSDAY, JUNE 19

8.30 A.M.	Leave Boston for Lakeville (Motor transportation will be provided).	
10.00–12.00 A.M.	Inspection of the hospital and clinical demonstration	Dr. Z. B. Adams and Associates.
12.30 P.M.	Luncheon	

First Scientific Session

1.30 P.M. Symposium on Treatment of Tuberculosis of the Hip, Knee, Ankle, and Tarsus

1. Non-operative Treatment — Speaker to be announced.
2. Operative Treatment — Dr. Russell A. Hibbs, New York, N. Y. (By special request)

General Discussion

4.00 P.M. Leave by motor for Cape Cod

CHATHAM, FRIDAY, JUNE 20

Second Scientific Session

3. The Treatment of Fractures — Dr. Lorenz Böhler, Vienna, Austria. (By invitation)
4. The Fate of Dead Bone — Dr. J. Albert Key, St. Louis, Mo.

5. Bone Repair in the Presence of Aseptic Necrosis Resulting from Fractures, Transplantations, and Circulatory Disturbances
Dr. D. B. Phemister, Chicago, Ill.
6. Influence of Certain Factors in the Healing of Fractures
Dr. Kellogg Speed, Chicago, Ill.
7. Influence of Circulation on the Growth of Bone
Dr. J. J. Morton and Dr. Herman E. Pearse, Jr., Rochester, N. Y. (By invitation)

Discussion of Papers.

CHATHAM, SATURDAY, JUNE 21

Third Scientific Session

8. President's Address — Dr. Z. B. Adams, Boston, Mass.
9. An Operation for the Correction of Paralytic Genu Recurvatum
Dr. A. Bruce Gill, Philadelphia, Pa.
10. Fixed Paralytic Obliquity of the Pelvis
Dr. Leo Mayer, New York, N. Y.
11. Neurotrophic Lesions of Bone in Leprosy
Major Norman T. Kirk, U.S.M.C., Washington, D.C.
12. Spondylolisthesis — Dr. Henry W. Meyerding, Rochester, Minn.
13. Treatment of Fractures of the Neck of the Femur by Open Reduction and Fixation with a New Type of Nail
Dr. M. N. Smith-Petersen, Boston, Mass.

The Committee of Arrangements for the Boston Meeting of the American Orthopaedic Association has planned to hold the meetings of the twentieth and twenty-first at the Chatham Bars Inn, Cape Cod. Transportation will be provided for the ladies of the party who will motor down from Boston by way of Plymouth on the morning of June nineteen. The men of the party will spend the day at the Lakeville State Sanatorium which is about half way between Boston and Cape Cod. They will motor down from Lakeville in the late afternoon, joining the ladies in time for dinner. The scientific sessions will occupy the forenoons of the twentieth and twenty-first. Golf courses will be close at hand for those who wish to play. In addition facilities for bathing and small boating will be available. Special excursions will be organized for the ladies to visit quaint old Provincetown and other neighboring points of interest. Evening entertainments will also be provided.

Those expecting to attend the meeting are requested to notify Dr. Z. B. Adams, 166 Newbury Street, Boston, Mass.

Members and guests should make their reservations at once:

For the Chatham Bars Inn, June 19, 20, and 21, of Mr. Grant, Room 803, 10 State Street, Boston.

For the Hotel Statler, Park Square, Boston, for June 18.

Members who wish to attend the meeting of the American Medical Association in Detroit, which begins June 23, 1930, may remain on Cape Cod if desired until early Sunday. A train leaving Boston at 3.15 P.M., over the Boston and Albany, arrives in Detroit at eight o'clock Monday morning, June 23.

The Journal records with regret the deaths of two members of the British Orthopaedic Association: Mr. W. M. Oakden, of St. Luke's Hospital, Lowestoft; and Sir Anthony Bowlby, of London.

Just after the January issue had gone to press, *The Journal* was advised of the sudden death of Dr. George I. Marshall, of Kokomo, Indiana. For many years Dr. Marshall had specialized in orthopaedic surgery, and was in that department of the service during the World War.

The Journal also records with regret the death of Dr. J. W. Cokenower, of Des Moines, Iowa. Dr. Cokenower died suddenly on April 16, 1929.

The Ninth Annual Convention of **The International Society for Crippled Children** was held in Toronto, March 17, 18, and 19. A report of the convention will appear in the next issue of *The Journal*.

The Twenty-sixth Annual Meeting of the **National Tuberculosis Association** will be held in Memphis, Tennessee, May 7, 8, 9, and 10, 1930. A program of unusual interest has been prepared.

The New England Physical Therapy Society will hold its Third Annual Meeting in conjunction with the American Physical Therapy Association at the Copley Plaza, Boston, on April 16, 17, and 18, 1930. In addition to the papers planned and the discussion following, there will be an interesting display of modern apparatus for use in physical therapy.

The $450,000 addition to the Oklahoma State Crippled Children's Hospital has recently been completed. **The Oklahoma Society for Crippled Children** reports that the number of children given hospital treatment in 1929 was 924. Clinics were also held in thirty-four different counties, and a total of 1296 children were examined.

On January 1, 1930, the **Southern Orthopaedic Hospital** was opened in Richmond, Virginia. Orthopaedic surgery is to have a large place in the work of this hospital, and a physiotherapy department, including hydrotherapy, is available, as well as extensive x-ray equipment. A children's ward, especially for orthopaedic cases, is also planned. Dr. Thomas F. Wheeldon is Chief of Staff.

At the meeting of the American and British Orthopaedic Associations, in London, on July 4, 1929, the **Robert Jones Medal** was presented to Mr. E. P. Brockman, of London, for his prize essay on club-foot. It is of interest to know that this excellent piece of work is being published as a monograph by John Wright of Bristol, England. Copies will be available in the United States, or may be ordered directly from the publisher.

The Annual Meeting of the **Los Angeles Orthopaedic Club** took place on March 3, at the Elite Café. The new officers were elected for the year as follows:

Trusten M. Hart, M.D., President.

Harold D. Barnard, M.D., Vice-president.

H. W. Spiers, M.D., Secretary and Treasurer.

Dr. Chester Stock, of the Carnegie Foundation and of the California Institute of Technology, gave a talk on the La Brae Fossil Pit and the bone pathology found in certain groups of animals unearthed there.

Dr. Steele F. Stewart and Dr. Vernon Thompson gave a ten-minute motion-picture demonstration of ramisection in both the cervical and lumbar regions.

Among the guests present was Captain Mostamonte, of the Spanish Army. He responded to introduction with a friendly and interesting address.

Announcement has recently been made of the **Eastman Medical Films**. In recent years the conviction has gradually grown that motion-picture films of high-grade production are of considerable value in all branches of medical science. These are being used increasingly in teaching. In appreciation of the place which they occupy in medical instruction, The American College of Surgeons has cooperated with the Eastman Teaching Films, Incorporated, a subsidiary of the Eastman Kodak Company, in the production of a number of these films. Further information may be obtained from Mr. J. Bentley Squier, Chairman, Board on Medical Motion Picture Films, 40 East Erie Street, Chicago, Illinois.

The Annual Meeting of the **Czecho-Slovakian Orthopaedic Society** will take place on June 28 and 29, 1930, at Zlín and Luhačovice, Moravia.

The meeting on the first day will be held at the Industrial Hospital at Bata-works, Zlín. The subject discussed will be: Feet and Shoes,—the anatomy and physiology of the foot; medical experience in boot manufacture; damage caused by poorly made shoes. The principal speakers will be Dr. Tobiášek, Dr. Račanský, and Dr. Nebesk´.

On the second day the session will be at the inland watering place, Luhačovice. The subject will be: Orthopaedics and Hydrotherapy. The principal speakers will be Dr. Cmunt and Dr. Glücksmann.

Guests may participate in the discussion not only of the above mentioned subjects, but in all questions of orthopaedic surgery.

Members of the American Orthopaedic Association have received a special invitation to this meeting. Further particulars may be had upon application to the President of the Society, Dr. Otaker Schulz, Chodská 16, Prague XII.

Reunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux

Une Réunion scientifique vient de se constituer dans le but de grouper les travaux de l'Ecole Bordelaise, en matière d'orthopédie et de chirurgie de l'appareil moteur.

Ces séances auront lieu quatre fois par an: les troisièmes jeudi de janvier, de mars, de mai, et de novembre, à 17 heures, à la Maison Demons, 17 Rue du Professeur Demons, Bordeaux.

Les demandes d'adhésion doivent être adressées au Président de la Réunion: Professeur Rocher, 17 Rue du Professeur Demons. .

Les ordres du jour seront annoncés par les journaux médicaux de Bordeaux.

Les chirurgiens, les médecins, les radiologistes, les internes des hôpitaux qui s'interessent à ces questions, sont invités à assister à ces séances et à collaborer aux travaux de la Réunion (adresser les demandes de préférance huit jours à l'avance avec le titre de la communication, au secrétaire général: Docteur Ch. Lasserre, Rue de Cursol 29, Bordeaux).

La première séance aura lieu le 16 janvier 1930.

L'assemblée générale du 9 décembre 1929, a fixé ainsi le bureau de cette Réunion:

Président: Le Docteur H. L. ROCHER, Chirurgien des hôpitaux, Professeur de clinique chirurgicale infantile et d'orthopédie.

V. Présidents: Le Docteur M. CHARBONNEL, Chirurgien des hôpitaux.
Le Docteur GOURDON, Chargé de cours à la Faculté.

Secrétaire général: Le Docteur Ch. LASSERRE, ancien Chef de clinique.

Secrétaires des séances: Le Docteur R. GUERIN, Le Docteur MAGENDIE } Chefs de clinique.

Trésorier: Le Docteur G. ROUDIL, Chef de clinique adjoint.

The first session of the newly organized **Reunion d'Orthopédie et de Chirurgie de 'Appareil Moteur de Bordeaux** was held on January 16, 1930. At this meeting, among other papers the following were presented:

Dr. Charbonnel and Dr. Massé presented a paper on "Luxation of the Tibia at the Outside by Rotation on the Vertical Axis". This condition is considered very rare. Reference is made to the case reported by Guillemin, of Nancy, and presented at the Société de Chirurgie de Paris in May 1929, by Mouchet. The luxation is usually easily reduced by manipulation without anaesthetic, and results have been reported as being good. It is considered, however, by the author, that it is probably a more thorough procedure to operate, in order to remove the fractured tibial spines and the torn cartilage, and the results of these operations have been excellent.

Dr. H. L. Rocher and Dr. G. Roudil presented a case of osteochondrosis of the left elbow, apparently resulting from earlier trauma. The patient was a man forty-six years of age. Radiograph showed presence of eighteen foreign bodies, located in the anterior portion of the articulation. Condition had existed five years with the function of the elbow but little disturbed. There was some deformity of the head of the radius and on the internal side of the coronoid process. The authors agree as to the etiology with the opinion held by Lexer, and more recently presented by Henderson and Jones.

Dr. Ch. Lasserre presented a case of instability of the hip after reduction of congenital dislocation, with a spontaneous reshaping of the acetabulum. The child was operated upon in December 1913, at the age of three years. In August 1914, immobilization was repeated, and in October 1914, apparatus was removed and postoperative treatment was begun. At the age of nine the child walked without limp. In 1922 abduction was limited and the patient showed a limp. In 1925 there was abduction to thirty degrees and in this position the hip was stable, but in flexion and adduction the hip was unstable. Two radiographs were taken at this time in the two positions of abduction and adduction. In abduction the center of the head was in the cotyloid cavity, which showed a double concavity. In 1928 the patient was again seen. The abduction was still further diminished, but the hip was stable. Radiographs showed a reshaping of the cotyloid cavity, which entirely held the femoral head. Inference was made that the gait of the leg in abduction had a tendency to stabilize the hip.

A case of congenital dystrophy of the femur in a child of three years was presented by Dr. Edouard Papin. The child walked at eighteen months. A clinical examination showed no congenital dislocation. Radiograph showed a normal cotyloid cavity, but shallow. The femur, on the other hand, showed the deformity usually presented in dislocation of the hip, smaller in size, short neck and anteversion less developed than on the other side. Apparently the dystrophy had affected only the femur and resulted in one of the rare forms of congenital deformity.

Dr. Edouard Papin presented a case of comminuted subtrochanteric fracture of the femur. The patient, a man of sixty-eight, had a fall of two and one-half meters, and sustained a comminuted subtrochanteric fracture with five fragments, marked deformity, and with seven centimeters shortening. Reduction under general anaesthesia was verified by x-ray. Treatment by extension of the thigh and leg, by the apparatus of Pouliquen, gave excellent results, with one centimeter shortening.

Dr. Gourdon reported a case of a vertical fracture of the lower thirds of the body of the fourth lumbar vertebra. Vertical fractures limited to one body are extremely rare. They differ from transverse fractures not only in diagnosis of their form, but also in their treatment. They recover quickly and completely, for they are not subject to the force of the weight-bearing of the trunk.

Dr. H. L. Rocher and Dr. Veyssiere reported a case presenting the syndrome of Volkmann following rupture of the flexors of the forearm. The symptoms appeared three weeks after an epiphyseal separation of the radius, with marked displacement. The apparatus was removed on the eighth day. In regard to the pathology of this syndrome, in this case they eliminate the theory of compression producing ischaemia. They considered the condition as due to the elongation rupture of the musculotendinous portion of the flexors, occasioned by the hyperextension, on the theory that the elongation was sufficient to be followed by diffuse hemorrhagic infiltration in the perimuscular and intramuscular tissues, producing areas of myositis which allowed the development of

the syndrome of Volkmann, of which the evolution in this case had been particularly favorable and rapid.

Dr. Ch. Lasserre presented a case of neurinoma of post-tibial nerve. The case reported was in a woman of sixty, who had shown for more than thirty years an extremely painful swelling posterior to the internal malleolus. In December 1929, an operation was performed with removal of the tumor, which involved the terminal branches of the posterior tibial nerve. Examination showed a glioma, with no evidence of malignancy. The continuity of the nerve was preserved and the condition was entirely relieved.

Dr. H. L. Rocher and Dr. R. Guerin presented six cases of osteosynthesis in fracture of the external condyle in children, by pinning. The operative indication is based on the instability of the replaced external condyle. The fixation is very easily obtained by a pin which, by a simple push, is placed in the condyle of the humerus. Occasionally it is necessary to prevent the rotation of the condyle about the pin by the supplementary fixation by a second pin. The pin is left in place for at least six days, and may be easily removed. The operation has been done in children from three to ten years of age, with excellent results.

Dr. Forton presented a case of lumbar scoliosis in an adult, in which there was evidence of tabes and extensive arthropathy of the knee. The patient was a woman of fifty-three, with symptoms of fulgurating pain in the legs. The right knee showed deformities with extensive changes, which had developed rapidly. The spinal column showed deviation of the lumbar region with absence of torsion, with no pain and no muscular contraction. The patient also presented definite signs of tabes. Although the Wassermann was negative, the evidence of tabes was undoubted.

Dr. H. Dijonneau and Dr. P. Lafargue presented a communication on the professional reeducation of the muscles in infantile paralysis. The different movements in this form of treatment were explained in detail.

Dr. Ch. Lasserre reported a case of accidental section with loss of substance of the posterior tibial nerve, followed by removal of a neuroma with nerve graft. The patient was a child of twelve years of age who sustained injury of the left foot and a cut behind the ankle by a mowing machine. Following immediate treatment with suture of the tendo Achillis, the wound healed temporarily. A month later a mal perforant developed. After four months, operation was performed,—the posterior tibial nerve was dissected out, a neuroma was removed, and a nerve graft was inserted to supply the lack of continuity occasioned by the cut. The mal perforant healed in twenty days after operation. Final results of the nerve graft not yet determined.

French Orthopaedic Society

The Eleventh Congress of the French Orthopaedic Society was held on October 11, 1929.

The subject of "Juxta-articular Osteitis" was presented by Dr. Andrieu, of Berck.

In a very clearly presented report, Andrieu gives the result of his studies of juxta-articular osteitis in the long bones of the limbs, and in the scapula and pelvis, with special reference to the tuberculous osteitis. His work is based on the observation of 168 cases (151 patients, 11 presenting two localizations and 3, each with three localizations). More than one-quarter of the patients show other tuberculous manifestations, particularly the young. The joints most frequently affected are the hip, knee, elbow, and shoulder. The development of the osteitis into the articulation can be produced by the destruction of the cartilage, or by the involvement of the synovial membrane. In this extension, if the lesion is bulbar, its growth is arrested for a time by the cartilage, which is later destroyed *en masse*, or is perforated at a single point, finally giving way, and the epiphysis is then involved in its turn. At that time the joint is no longer protected except by the diarthrodial cartilage, and this obstacle finally yields to the process.

The invasion of the articulation can be produced through the synovial membrane which is invaded by areas of contagious osseous foci, the proximity of which depends upon the anatomy, but before these are invaded, the synovial membrane presents lesions due to irritation because of the propinquity, and of the thickening about the condyles of the femur, which has been produced by the hydro-arthroses. The hydro-arthroses do not show the bacilli, and are due to the proximity of the inflammatory focus.

The symptomatology of this juxta-articular osteitis is in the beginning very variable. Sometimes nothing calls attention to the condition, and the lesion is found first by the radiograph, either by chance, or by comparison with the opposite joint.

Usually, however, the patient presents definite signs, has complained of a vague pain, exaggerated by fatigue, which disappears at times, and reappears. The pain is located usually near the joint, but in case of the hip, the pain is often referred to the knee. The articulation is only slightly disturbed in its function. In the lower limbs, a limp is usually intermittent, as is also the pain, and disappears as does the pain during rest. In the upper limbs the first symptom is more often an abscess than pain. Sometimes it appears insidiously and is found only in the opening of a fistula, for which the patient comes for treatment.

The examination should always be supplemented by good x-rays, showing the suspected areas, taken in both planes. They should also be bilateral because of the necessary comparison of the two sides.

The lesions progress by successive attacks and remain latent in the intervals. but it is probable that many times the evolution of these is more or less quiet, and the clinical symptoms are not suggestive before the condition is found by the radiograph. The diagnosis is, as a rule, not difficult, and should not be so in those cases in which the articulation is attacked and there is seen a slight atrophy. Simultaneously, an abscess develops in the intermuscular area, which does not allow the normal amount of motion, but at the same time the limitation of the motion is slight; but with a suppurative arthritis, it is considerable. Puncture of the articulation as well as the radiograph determines the diagnosis. When there is a fistula and the location of the disease can be definitely fixed in a deep area,—as for example the hip—a radiograph, after the injection of lipodal, demonstrates exactly the state of the lesion.

The importance of the diagnosis rests always in the determination of the relation of the lesion to the joint, but it is also necessary to determine the nature of the lesion. It is most important to determine this without delay in order to avoid the operative interference, which might be a great error,—as for instance, in syphilis, which should always be considered even in those cases in which it seems scarcely probable. The *réactions sériques* aid in determining the nature of this disease, but it is necessary to remember that they do not replace clinical evidence, and also that specific treatment used in case of doubt is a very valuable agent in the diagnosis.

The prognosis of juxta-articular osteitis depends on the destruction to the neighboring joint—nearly inevitable in the hip, very often in the upper portion of the ulna and of the tibia. It is more rare in other locations. The prognosis is dependent upon the extent of the lesion, its duration, its tendency to invade, and its accessibility for operation. Arthritis often may be avoided by operation, but it may develop later in spite of an intervention which has been resorted to too late. It may happen that operation can be injurious by too extensive curettage destroying the articular cartilage or perforating the synovia, emphasizing the lesion which the operation was designed to prevent. Sometimes it is true that opening of the synovial membrane is without serious results but more often arthritis develops with all the complications. When the osteitis appears to be cured, either spontaneously or after operation, it is still necessary to preserve a careful inspection as to the after developments. Sometimes it happens that a lesion which seems to have definitely disappeared returns at the end of several years, and invades then the joint which up to this time had been preserved. The arthritides which are consecutive to these osseous foci are important, and have a prognosis which is equally serious when the joints themselves have been invaded early. Also, it is necessary to bear in mind the

orthopaedic sequellae, such as elongation or shortening, or lateral deviation which supervenes on the juxta-articular osteitis. This juxta-articular osteitis, even although it does not invade the joint, results in certain difficulties connected with the joints (such as stiffness or malposition as a result of muscular contractions), which may improve to a great extent in the following years or which may persist indefinitely.

The treatment of the juxta-articular osteitis is either conservative or operative. The conservative consists of treating the lesion as if the arthritis existed, and in this case the immobilization of the joint in plaster is used or an apparatus which permits the inspection of the region affected, and the use of local heliotherapy if its effect is considered valuable. The abscesses should be punctured, the fistulas dressed, and this care is continued not only until there are no longer articular symptoms, but much longer, until the radiographs show a complete cure.

The operative treatment aims to prevent the extension to the articulation, and to eliminate the lesion. The osseous focus is attacked and destroyed by free curettage; and if it is already open with a fistula, through drainage. The author shows by his statistics that when it is necessary to operate, the operative treatment which may forestall the arthritis furnishes a more complete and more rapid cure. It is necessary to operate from the diagnostic point of view when the lesion is old. When the lesion is in an early stage, there is no indication for immediate intervention. The member can be immobilized and the case watched by frequent radiograms.

The technique is simple, except in the hip, where it is necessary to make the incision used for resection where it is difficult to avoid opening the synovial membrane. Immobilization should be complete, and continued for a long time,—ten months, even two years, and for some months after all symptoms have disappeared.

Dr. Tavernier, of Lyon, presented the subject of "The Recurrent Luxation of the Shoulder".

In his clear and thoroughly illustrated paper, the author states that although the larger part of the important works on the recurrent luxations of the shoulder have been published in Germany and the United States, with a large amount of material, it is the French orthopaedic surgeons to whom we are indebted for the knowledge of the cause and of the treatment of this affection.

Grégoire and Louis Bazy called attention several years ago to the importance of the deformity of the humeral head, which had appeared up to that time to have excited but little interest. It was Oudard, of Toulon, who described in 1926 the technique of an osseous prop, which is, up to the present time, the only method which has not had relapses. Tavernier included in his report that it is the antero-internal luxations of the shoulder which are the most frequent. The recurring posterior luxation is very exceptional.

Etiology: The age of election is from twenty to thirty years. The ordinary luxation of the shoulder is about eight times less frequent in women than in men; the recurrent luxation is only four to five times less frequent. In the recurrences the important rôle is the malformation of the humeral head. The recurrent luxation, moreover, most frequently occurs in athletes and epileptics. It is necessary, however, to take account of the importance of the causal traumatism, and not to put too much stress, under the pretext of a congenital deformity of the head, on the insignificance of the traumatism. It is logical to think that too short an immobilization after the reduction of the first dislocation favors the relapse by preventing the regular cicatrization of the torn capsule.

Symptoms: The primary luxation appears entirely as an antero-internal luxation of the subcoracoid variety. Nothing in the symptoms may give rise to the opinion that this will be followed by a series of luxations more or less spontaneous. Only in certain cases the rather insignificant trauma as an etiologic factor, or epilepsy in the patient, or the special radiographic aspect of the head would cause a fear of recurrences. The date and the frequency of the recurrences are extremely variable. More often the first is not produced until several months after the initial luxation; the following recurrences become more and more frequent, and the occasion of the trauma more and more in-

significant. With some patients the luxation appears on a very slight pretext and may reach twenty to sixty or even more than a hundred luxations, but more often the relapses are less numerous, and more frequently are seen to number five, ten, or twenty. The evolution toward the relapses more and more often is not constant. Exceptionally can be observed spontaneous cures,—that is to say, patients, after having been subjected to five or ten luxations during several years, can then definitely become free from all recurrences.

The reduction ordinarily becomes more and more easy and does not require an anaesthetic, but it sometimes happens after a series of easy reductions that a relapse becomes rebellious and demands most difficult manoeuvers or even open operation (Quénu).

It can be seen how often the symptoms vary, but one point remains constant—the character of more and more frequent spontaneous relapses. By the character of this symptom, the mistake of diagnosis with the most important complication—that of a relapse from a luxation from trauma—is avoided. These relapses of luxation would be better called habitual, for a patient is able to produce successively two or more luxations of the same shoulder without producing this special affection of the shoulder which we are now studying, if the relapses supervene from serious trauma, which would be sufficient to cause a luxation of a healthy shoulder joint. It is necessary to distinguish clearly the habitual luxations from the occasional relapses, which have not an unfavorable prognosis and which do not indicate any treatment other than that of the simple reduction. If this distinction of the habitual luxation from the true relapses of the traumatic luxation is easy, it then will be less difficult to differentiate the habitual luxations from those which are distinguished as "*l'épaule à ressort*". It is equally difficult to form a definite opinion of this affection. Certain surgeons who have operated upon these have appeared to have collected them under different names.

The observations by autopsy are rare. The museum of Dupuytren, for example, has but one specimen. Many of the classical cases are without clinical history. They have been grouped under the habitual luxations because this lesion resembles a type which is understood and allows the reproduction of the luxation, but nothing proves that it might not be a recent luxation or even a relapsed luxation. Many of the cases of Joessel, of Broca, and of Hartmann may come under this objection.

The operative observations are also incomplete, and more or less follow the usual type of operation employed. The extrascapular operation cannot demonstrate much more than the relaxation of the capsule. The opening of the articulation gives evidence more extended, but only the resection of the head furnishes the complete findings as to the deformity of the articular surfaces. The radiograph is an excellent method of investigation of the skeleton, but the information which it gives is not always easy to interpret. To avoid any possibility of error, the radiograph should always be taken in the same position, and this position should be, by preference, the external rotation which discloses the true profile of the head. Perthes recommended taking many pictures under different conditions, in order to avoid missing either a divulsed tuberosity or a foreign body. It appears, moreover, important to choose a position which is most capable of bringing out the appearance of a deformity of the head.

It appears that the tearing of the muscles in these recurring luxations should not be regarded as an occurrence of little importance. The laxity of the capsule is the lesion which is most often observed, but most operators do not consider either its degree or its exact position, and it is not certain that it has the importance which has been attributed to it. It is, moreover, the tearing of the capsule which undoubtedly allows the relapse. The anterior permanent break is not all of the pathology of the habitual luxation, but it is a necessary condition, for in order that the head should dislocate, it is necessary that it should move somewhat. If the displacement is made only in a large or a relapsed capsule, the luxation would not possess any stability. The reduction could be made almost without difficulty, which is always the case. The particular form of this kind of lesion is made by the shortening of the periosteal capsule, which was described by

Broca and Hartmann in 1895. The capsule at the place of the break tears the rim of the glenoid, and shortens the periosteum of the anterior face of the neck of the scapula, with which it is continuous, so that the head luxates forward on the shoulder on the denuded scapula. This lesion, found in one autopsy without clinical history, has appeared to the authors to indicate a relapsing luxation. They have compared the cases of Eve and Popke, but in reality this condition has not been observed again by any operator and if it corresponded to the pathological anatomy of the habitual luxation it is most exceptional. The lesions of the head of the humerus are often more exact. They are of two kinds,—a notch on the posterior portion, and a deformity of the same which gives to the silhouette of the head the form of an ax or mallet.

a. The notch is distinctly the lesion of the relapsed luxation. The position is on the posterior portion of the head, where, it is classically stated, it appears as an elevation of a portion of the bone in the form of a quarter of an orange. The bottom of the notch is lined regularly, but lightly raised and tortuous, without cartilage, or covered by a very thin and irregular cartilage. The dimensions vary; sometimes there is a wide gutter analogous to the bicipitale groove. Grégoire states that this notch is a congenital malformation, and the position of it corresponds exactly to the line of adhesion of the cephalic nucleus with the point of the tuberosity (an insufficient development, lack of use, or a heaping-up of the support of the anterior border of the glenoid). The notch explains both the primary luxation and the relapses. It is the only logical explanation of the recurring luxations, for it appears to be absolutely constant.

b. The hatchet-shaped head is a deformity described by Louis Bazy. It is recognized by Alibert, whom Bazy inspired to write his thesis in 1920, that this deformity is, like that of the notch, of congenital origin. Moreover, the relapsing subluxations depend on the malformation of the head, and either the posterior notch of Grégoire or the hatchet-shaped deformity of the head of Louis Bazy prepares for first and preserves later the capsular tear which allows the relapse.

The pathology of these luxations may be summed up as follows: Bony malformations, which prepare the capsule by distending it, the necessity for the first luxation by a traumatism which may be, moreover, less important than the fact that the capsule is rather weakened. The rôle of traumatism explains the predominence of this condition in men, athletes, and epileptics; the failure of cicatrization of capsular lesions preserved by the malformation of the head.

Treatment: The operative procedures are numerous, and are enumerated below:

1. Capsulorraphy, very often used; for a long time was the classic operation, described in France by Ricard in 1894. It is a vertical folding of the capsule, without the necessity of opening it. There has been, however, much of variety in this technique. Turner, of Philadelphia, prefers the axillary approach to the deltopectoral. It is an insufficient operation, rather blind and illogical. The late results are not satisfactory; the relapses are frequent.

2. The reinforcement of the capsule by shortening the tendons (subspinous and subscapular), and by the transplant of fascia lata, often followed also by relapses.

3. The suture of the torn capsule furnishes the results most inconstant and rarely definite.

4. The section of the muscles or autoplasty of muscles has been abandoned by all.

5. The only logical method of operation is that directed toward the bony deformity. The bone resection, the first bony operation which has been applied to the relapsing luxations of the humerus, is an operation very mutilating and should be used only as an ultimate resource. The arthrodesis of the shoulder results in an unfortunate infirmity. The tenodesis of Löffler and Henderson has been followed by relapses.

Only the bony masses of which Oudard, of Toulon, has determined the technique by an ingenious process and proved the value by statistics, are capable of producing a cure of the relapsing luxations of the shoulder joint. Oudard has had the idea to elongate the coracoid process by an osseous graft which forms in front and on the inside of the

articulation a kind of elephant's trunk, directed from below, and against which the head would impinge if there is a tendency for an antero-internal displacement.

The great superiority of this operation over all others which we have been able to consider up to the present is that, not interfering with the articulation, it produces no injury to it, even during the first months of the articular movements. On the other hand, the buttress, being bony, does not involve the risk of a later distension which is observed after all of the tendon plasties. As observed by Oudard, one can hardly imagine a relapse of the luxation to be possible by this method. In order that such should occur, it would be necessary that the head break this buttress, which would require a very considerable force, and even in this case he says it is probable that the reduction would be followed by consolidation of the graft, which would oppose then a further relapse. In fact, no relapse of luxation has been published as occurring after this operation of Oudard.

The definite technique of Oudard consists of splitting the coracoid process longitudinally by an oblique section, which leaves the internal segment in contact with the insertions of the coracoid biceps and the external segment with its base implanted on the spine of the shoulder. After shortening the subscapular muscle, he connects the extremities of the split apophysis by metal wire, elongating also the spine to the extent of the length of the section of the division. The operation is simple, easy, and without risk. It does not in any way limit the movement of the part, and it is the only one which has cured without relapse all of the cases to which it has been applied. As soon as the relapses are repeated the indication for operation is definite, and it is the operation of Oudard which should be employed.

CLINICAL CONFERENCES AT THE HOSPITAL FOR RUPTURED AND CRIPPLED, NEW YORK CITY

CONFERENCE OF OCTOBER 1929

REDUCTION OF FRACTURE OF FEMUR UNDER SPECIAL ANAESTHESIA.

Dr. Lewis Clark Wagner presented three cases illustrating the treatment of fresh and of old fractures about the femur. Emphasis was laid upon the fact that greater relaxation of muscular tissue was secured, especially in the fracture of the neck of the femur, and thereby greater abduction executed. The patients presented no after-effects and the nursing care was much simpler after plaster was applied and patients returned to the ward.

Case 1: Fracture of neck of the femur.

Case 2: Malunion with three inches overriding of upper third of the femur. Fragments were separated and a Steinmann pin was inserted and limb placed in traction and suspension, with a fifty-pound weight the first day. On the second day fragments were in position, and there was union at end of six weeks.

Case 3: Malunion of upper third of femur with extreme angulation. Wedge osteotomy. Correction of deformity and application of plaster.

Case 4: Malunion with angulation in double fracture of shaft of femur. Removal of wedge of bone. Correction of anterior and lateral angulation. Patient weighed 250 pounds. End result.

OSTEITIS FIBROSA CYSTICA, MULTIPLE.

Dr. William B. Coley presented a case: J. H., male, aged fifteen months, was admitted to the Hospital for Ruptured and Crippled on September 16, 1929, with the following history:—

Six months previously the mother had noticed a swelling underneath the baby's right jaw; this was accompanied by some falling off in general health. On July 13, 1929, an operation, consisting of removal of a small lump from the right inguinal region, had been performed at Bellevue Hospital. This was pronounced a giant-cell sarcoma by

Dr. D. Symmers, pathologist. The diagnosis made at Bellevue Hospital was that of sarcoma of long bones, jaw, and skull. A blood Wassermann test was negative. *X-ray report*, July 16, 1929, reads: "Numerous areas of destruction in the skull. There are similar areas in the bones of the left forearm and left femur. Lesions suggest metastatic neoplasm." *X-ray report*, July 19, 1929, reads: "Metastases of all long bones and skull as previously described. Diffuse engorgement of both lungs." On July 25, 1929, the child was discharged from Bellevue Hospital and shortly thereafter was admitted to St. John's Long Island City Hospital. Here a cervical node was removed and examined by Dr. J. Werne, pathologist, whose report is as follows:—

Microscopic examination reveals the presence of a very small residuum of lymphatic tissue arranged as small circular and elliptical accumulations of mature lymphocytes. The remainder of the section is made up of connective-tissue tumor cells of varying sizes and shapes many multinucleated, exhibiting wide variation in staining property and many mitotic figures. There is no evidence of the normal adenoid reticulum in those areas invaded by tumor tissue. The capsule of the lymph gland also shows infiltration with tumor cells. There are occasional inflammatory foci, comprising polynuclear leucocytes.

Diagnosis: Giant-cell sarcoma metastatic to lymph node.

Three weeks prior to his admission to the Hospital for Ruptured and Crippled the patient began to cough, and during the last months had lost ten pounds in weight. *Physical examination* on September 18, 1929, as reported by Dr. Armitage Whitman, who was called in consultation, showed a pale infant apparently in poor health. His eyelids were somewhat swollen and reddened. He had a peculiar expression on his face and a very peculiar high-pitched brassy cry. There was a visible swelling beneath both mandibles. The belly was symmetrically distended. The limbs were held habitually flexed, but could be passively extended. There was a scar of incision in the right inguinal region. The inframaxillary lymph glands on both sides were markedly enlarged. The anterior and posterior cervical glands on both sides were palpable; they were hard and not tender. The skin was freely movable over them, and they themselves were movable on the deep tissues. The maxillary glands on both sides were enlarged and palpable as were also the femoral glands. The epitrochlear glands were not felt. The abdomen was markedly distended and resistant. The spleen could not be felt, but it was thought that the area of splenic dullness was somewhat increased. The liver edge could not be felt but the liver dullness was percussed one inch below the costal margin. The abdomen was of a peculiar elastic resistance. No masses nor tenderness could be felt. There was dullness in the flanks on both sides, also a shifting dullness.

A microscopic section was submitted to Dr. W. H. Probert, Pathologist of the Hospital for Ruptured and Crippled, whose diagnosis was endothelioma. A section was examined also by Dr. J. Ewing, Pathologist of the Memorial Hospital, who pronounced it: osteitis fibrosa cystica and hyperplastic tuberculosis of lymph node.

After a careful study of a series of roentgenograms taken at the Hospital for Ruptured and Crippled, a diagnosis of osteitis fibrosa cystica, multiple, was made. Dr. Coley stated that the condition apparently had had very little effect on the child's general health; there was no evidence of malacia. Under careful feeding and physiotherapy treatment, the glands had nearly disappeared and the child's general health had shown decided improvement.

Dr. Coley stated that the generalized type of osteitis fibrosa cystica is of extremely rare occurrence; only two cases had come under his own observation. The other was a male aged fifty years, who was admitted to the Hospital for Ruptured and Crippled on November 21, 1919, with a history of having been treated at various hospitals during the preceding four years. This case was the type associated with giant cells. The tissue closely resembled that of giant-cell sarcoma. The patient grew worse steadily and on his readmission to the Hospital for Ruptured and Crippled on May 26, 1925, it was found that he was in the last stages of the disease. He died on July 15, 1925. The microscopic diagnosis on the section removed in 1919 as well as at the time of his death

was giant-cell sarcoma. This case was reported in full in the *American Journal of Surgery* (VI, 602), May 1929.

Dr. Coley stated that one of the most complete studies of the subject of osteitis fibrosa cystica or von Recklinghausen's disease was made by J. J. Morton (*Archives of Surgery*, IV, 534, May 1922).

Morton divides these cases into two main groups with subdivisions as follows:—

Group 1.—Without giant-cell sarcoma:

A. With multiple cysts, fibrosis, and malacia confined to a few bones.

B-1 With multiple cysts, fibrosis, and predominant general malacia.

B-2 With multiple cysts, fibrosis, general malacia, and hyperostosis.

Group 2.—With giant-cell sarcoma:

A. With cysts, fibrosis, and tumors, but no marked malacia.

B-1 With cysts, fibrosis, and tumors, and marked malacia.

B-2 With cysts, fibrosis, tumors, malacia, and hyperostosis.

According to Morton a search of the literature revealed only sixty-three cases, thirty-seven of which he placed in the first group,—*i.e.*, without giant-cell sarcoma, and twenty-six in the second group, with giant-cell sarcoma.

Regarding the end results, Morton found the following: In *Group 1* subdivision *A* (22 cases) the prognosis was essentially good, while in subdivisions *B-1* and *B-2* (8 and 7 cases respectively) death occurred in nearly every case. It is interesting to note that in *Group 2*, associated with giant-cell sarcoma, while practically all ended fatally, in some cases death was delayed for more than ten years. The youngest patient on record that Morton was able to find was four years old.

Dr. Coley believed that the case presented was the youngest one on record, although he understood there were one or two cases observed at the Babies' Hospital, not yet reported. He said it was interesting to note that the first physical symptom in the case presented was enlargement of the glands of the neck and groin. One of these glands had been removed and on microscopic examination was pronounced a giant-cell sarcoma. A roentgenogram of the chest revealed multiple cysts in most of the bones of the thorax. This led to further roentgen-ray examination of the rest of the body, which revealed involvement of practically all the skeletal bones. The patient himself apparently had had very few symptoms connected with the condition; there was no marked malacia, no hyperostosis, and without a roentgenogram one would not be led to suspect there was anything wrong with the skeletal bones.

Congenital Hypertrophy of Lower Extremity.

Dr. H. E. Reading presented a case of an eight-year-old boy with the chief complaint of enlargement of the left lower extremity and difficulty in walking because of its huge size. The present illness apparently dates from birth, when it was noted that the left lower extremity had developed much more rapidly than the right. As the child grew a greater length developed in the left lower extremity than in the right. This has prevented the wearing of the ordinary type of civilian clothes. The past history is essentially negative, outside of the usual childhood diseases. The family history is negative.

The examination shows, child is slightly undernourished, with a markedly enlarged left lower extremity. The child seems to be of normal intelligence for his age. There is a rather prominent irregular, pigmented nevus over the back of the neck. The chest, including the heart and lungs, is apparently negative. The abdomen is negative. There is marked hypertrophy evident from the region of the iliac crest on the left down to the toes. The tissues seem to be somewhat doughy and swollen, but there is no pitting present. The right foot presents three webbed toes, while the left foot has six toes, the central four being webbed and the sixth toe being attached to a pedicle of the fifth metatarso-phalangeal articulation. There is rather marked hypertrophy of the third, fourth, and fifth toes of the right foot. (The description of such an abnormality being very difficult, the following photographs are included.) A diagnosis was made of

FIG. 1

FIG. 2

FIG. 3

hemihypertrophy of the congenital type with apparent gigantism of both lower extremities. Because of the difficulty presented in walking, it was decided to amputate the left lower extremity at the middle third of the thigh.

Measurements	*Left side*	*Right side*
From anterior superior spine to external malleolus	30 inches	24 inches
Thigh (circumference)	16 "	12½ "
Knee "	18 "	10½ "
Calf "	13½ "	9½ "
Foot (length)	13 "	10¾ "
Circumference of forefoot	14½ "	8½ "

FIG. 4

Postoperative view

Amputation of left lower extremity at middle third of the thigh was done September 27, 1929. The weight of the leg and thigh was seventeen and one-half pounds. The weight of the entire body of the child was sixty-four pounds before the removal.

A résumé of the literature was included. In the discussion it was concluded that up to 1927 fifty-three cases were reported in the literature from various countries.

Approximately seventy per cent. of the cases reported showed the hypertrophy on the right side of the body, about ninety to ninety-five per cent. of the patients being diagnosed in childhood.

Congenital hemihypertrophy is not considered as an hereditary disease but rather a morphogenetic anomaly originating in the early embryonic stage. It is the common belief that the asymmetry of the body in these cases is probably due to a disturbance in the normal process of twinning.

Gesell states, "Mental defect of some degree is found with disproportionate frequency in association with hemihypertrophy". —(About fifteen per cent. of his cases showed mental subnormality.)

From forty to fifty per cent. of these patients have some skin changes which vary from a slight roughening to that of nevi and telangiectatic areas in different parts of the body. The outstanding anatomical feature of congenital hemihypertrophy is the involvement of the skeletal system so that the increased size of a limb or a portion of the body is accompanied by hypertrophy of the bony structures of the affected side.

Milroy's disease is differentiated from congenital hypertrophy by the hereditary form of permanent oedema in the former without involvement of the skeletal system.

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CONFERENCE OF JANUARY 1930

CONGENITAL PSEUDARTHROSIS OF TIBIA

Report of Two Cases

Dr. Paul C. Colonna presented two cases of so called congenital pseudarthrosis of the tibia in children. One was in a child of about twelve who gave a history of having had the deformity as long as she could remember. The history in the early years of life was not available, but apparently the bowing of the right leg was noticed when the child was quite young. This patient had been operated on several times at various hospitals and each time the deformity had recurred. X-ray examination on admission to Bellevue Hospital showed this girl to be in good general condition, unable to walk on account of severe deformity of the right leg which was bowed outward and presented pseudarthrosis in its lower third. X-ray showed a well formed false joint at the lower third of the tibia with the ends of the fibula tapering and pointed. In November 1929 open operation was done using a massive bone graft from the opposite leg. The false joint was completely dissected out, leaving a gap in the tibia over which the graft fitted. The deformity of the fibula was also corrected and plaster applied from the groin to the toes with the knee slightly flexed and the foot in equinus. Since that time the course has been uneventful and six weeks after the original operation an open lengthening of the tendo Achillis was done. For the past month the patient has been up and about, bearing a moderate amount of weight on the limb. A recent x-ray shows extremely satisfactory bony union of the graft, although the patient at present is still in plaster and sufficient length of time has not elapsed to present the end result.

The second case was in a child of six who gave a somewhat similar history, having been operated on several times without satisfactory union. This child presented marked anterior bowing of the leg, and x-ray showed a right angle position of the tibia with a large false joint in the lower third of the tibia and a tapering atrophic fibula. Massive bone graft was done on this leg after resecting the false joint from the tibia, and this operation was performed in December 1929. A recent x-ray shows the graft in position and the deformity corrected, but sufficient time has not elapsed to conclude as to the success of the operation.

Dr. Colonna referred to the exhaustive paper of Melvin S. Henderson and the report of the seven cases that he had made in 1928 (*The Journal of Bone and Joint Surgery*, X, 483, July 1928). The pathological specimens obtained from the two cases presented would appear to show somewhat similar changes as those reported by Inglis in the *Journal of the College of Surgeons of Australia* (I, 194, Nov. 1928). The extremely unfavorable prognosis that all observers have made regarding this type of fracture was mentioned and stress was made that this is one type of fracture in which the massive bone graft would appear to be indicated par excellence. At a later meeting end results of these two cases will be presented.

CORRECTION

The Joural,, in January, carried a report of the meeting of the Czecho-Slovakian Orthopaedic Society held in Prague on September 28 and 29. On page 205, mention is

made of the paper presented by Dr. Galland of Berck-Plage, France, describing the mechanism of the evolution of the deformity in tuberculous spondylitis of the lumbar and dorsal spine. While this paper was presented by Dr. Galland, the statement should have indicated that the work reported was that of Dr. Jacques Calvé and Dr. Galland. For many years these two men have been associated in this work, and the short graft for this condition, here described for the first time, is a method for which Dr. Calvé is largely responsible.

PATHOLOGICAL CONFERENCE AT THE HOSPITAL FOR JOINT DISEASES, NEW YORK CITY

CONFERENCE OF JANUARY 1930

ABSCESS OF THE FEMORAL NECK.

Dr. Leo Mayer presented two cases, which, for lack of better diagnosis, he termed abscess of the femoral neck. The cases were almost identical in clinical course and pathological picture. Both occurred in young children, one in a boy of six, the other in a girl of eight. Both gave a history of limp and pain extending from the hip down to the knee. In one the symptoms had been present for fourteen months, in the other for two years. No definite diagnosis had been made, although in other hospitals tuberculosis of the hip, rheumatism, and infantile paralysis had been suggested as possibilities. Physical examination at time of admission showed a very slight limp which became definite only after the patients had walked enough to become a little tired. There was almost no restriction in the motions of the hip, either active or passive. At the extremes of motion, however, patients had slight pain. Diagnosis was made in each case by careful roentgenogram. The first x-ray picture showed nothing in the case of the little boy, but when one was taken in maximum external rotation, a typical area of rarefaction was seen. This area, approximately circular in outline, measured about one-half centimeter in diameter. Treatment consisted of operation. Incision was made over the trochanter and a drill hole was made down to the abscess. To be quite certain of the direction, an x-ray was taken with the drill in place. The abscess was gently curetted, tissue taken for culture and bacteriological examination. In the first case the wound was sutured tight, in the second case the wound was packed. In both cases cultures were sterile and guinea-pig inoculation has been negative. Microscopic slides showed some bone detritus and the nuclei of the bone cells were pyknotic. There was no evidence whatever of a reaction such as is seen in osteomyelitis. There were no granulations.

We must, therefore, frankly admit that both the etiology and the exact nature of these abscesses are unknown to us at the present time. Empirically the method of treatment has been found to be quite effective. The one case is entirely cured; the other has been entirely relieved of pain and the wound is rapidly healing.

TUBERCULOSIS OF THE ELBOW.

Dr. Samuel Kleinberg presented tissue and microscopic sections of a case of tuberculosis of the elbow joint. The patient was a young man who injured his right elbow seven years ago. He said he had a fracture. One year later he again hurt the same elbow in a fall. For a brief period he had severe pain in and stiffness of the elbow. Since then he has had a certain amount of stiffness of the joint but no other inconvenience.

In April, 1929, a swelling appeared on the outer aspect of the elbow. This was thought to be an abscess and was incised and the elbow was further treated by baking. The swelling recurred and recently became painful.

The physical examination at the first visit to Dr. Kleinberg's clinic was negative except for the right elbow. On the outer aspect of this joint there was a small fluctuating swelling in the region of the head of the radius. There was no infiltration about the

FIG. 1

Tissues from elbow joint showing numerous tubercles (×100).

joint and no local heat. The motions were restricted. Extension was checked at 130 degrees, and flexion at forty-five degrees. Within this range the motion was painless. The x-ray pictures showed marked irregularity of the ulna and radius. There were several areas of subcortical rarefaction in the head of the radius and the olecranon process of the ulna. The joint space was diminished. The findings were not characteristic of any special lesion.

Dr. Kleinberg's impression was that the man had an arthritis of the elbow, the result of two severe injuries. But as there was considerable uncertainty an exploratory arthrotomy was performed.

At the operation the joint was found filled with a vast number of soft, oval, flat rice bodies. The synovial lining was thickened and friable. The cartilage on the upper surface of the radius was replaced by friable connective tissue. The cartilage on the humerus appeared normal. Dr. Kleinberg concluded at the time of operation that he was dealing with a case of osteochondromatosis that was traumatic in origin.

Some of the synovial tissue and a few of the rice bodies were examined microscopically. The former was riddled with tubercles (Fig. 1), establishing the lesion beyond any doubt as one of tuberculosis. The rice bodies consisted of necrotic tissue surrounded by a membrane of flat cells.

This case is of special interest because neither the clinical evidence nor the radiographic findings suggested a diagnosis of tuberculosis.

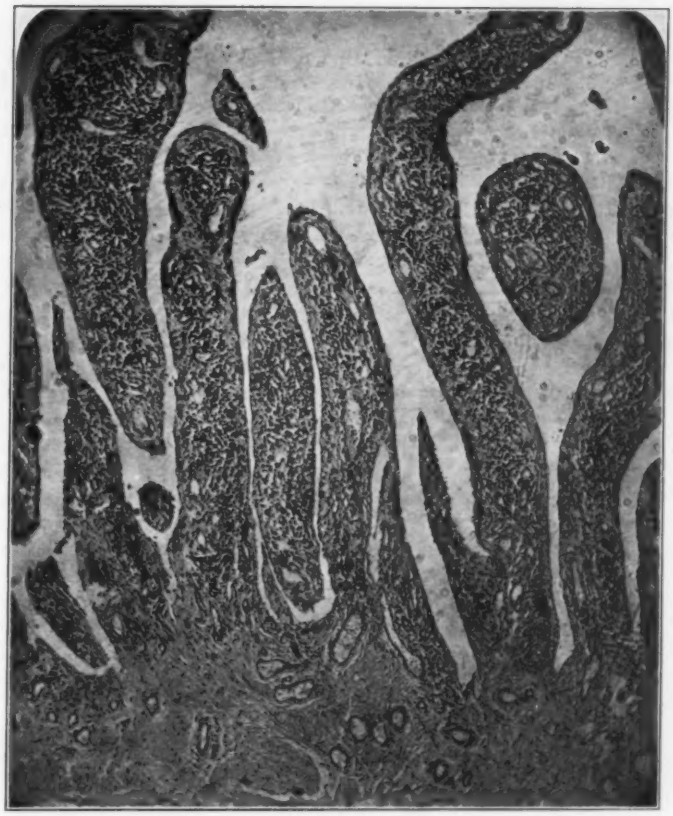

FIG. 2

Photomicrograph of synovial tissue showing numerous vascular villi.

SYNOVIAL TUBERCULOSIS.

Dr. Joseph Buchman presented a case of an eleven-year-old girl, who was admitted to the service of Dr. Kleinberg with an indefinite history of injury to the knee while bathing about four months previously. There was no immediate disability. One week later the knee became swollen but there was no pain, limp, rise in temperature, nor night cries.

She gave a family history of pulmonary tuberculosis in an uncle with whom she was in contact. She had had otitis media and influenza at one year of age, whooping cough and chicken pox at two years of age, and mumps at three years of age.

Examination showed that the patient was anaemic and in rather poor health. She walked well without assistance and without a limp. The left knee was moderately warm and swollen, the suprapatellar pouch was prominent, and there was bulging on both sides of the patella. A patellar click was present. Extension and flexion were complete but painful at the extremes of motion. X-ray examination was negative save for a thickening of the soft tissues. The chest revealed dullness and harsh bronchovesicular breathing in the upper lobes and x-ray examination showed infiltration of both apices. The Wassermann test and a quantitative tuberculin test were negative. The blood examination showed a hemoglobin of seventy-five per cent., 4,800,000 R.B.C., 9,500 W.B.C., neutrophils fifty-nine per cent., eosinophils three per cent., and lymphocytes

thirty-eight per cent. The joint was tapped and two cubic centimeters of thick glairy yellowish fluid was removed. Microscopic examination showed numerous polymorphonuclear cells. The culture was negative.

Clinically, the case appeared to be one of a chronic villous synovitis; but in view of the age of the patient, the history of tuberculosis in the family, and the tuberculous lesion in the lung, a secondary diagnosis of synovial tuberculosis was made.

On operation the joint was found to contain an innumerable quantity of minute rice bodies with very little fluid. The synovia presented numerous villi. A synovectomy was performed and the semilunar cartilages were removed. The patient made an uneventful recovery.

The specimen showed hundreds of minute villi, some of which had tiny white rice bodies attached to their tips. The villous formation in the quadriceps pouch was somewhat larger. There was no deposition of fibrin, no ulceration of the synovial lining, and no gross tubercles were seen. The rice bodies measured from two to three millimeters in their greatest diameter and were soft. Microscopically there was a greatly vascularized villous synovitis (Fig. 2). The infiltration was almost entirely lymphocytic. There were no tubercles. In some areas there was old blood pigment. The rice-body formations which were observed in some places to consist of a pinching off from the tips of the villi, were small masses lined by a superficial layer of cells, the centers of which were completely necrotic. A smear of the joint contents revealed crushed rice bodies and numerous polymorphonuclear, neutrophil, and mononuclear cells. No tubercle bacilli were found. All cultures were negative until the end of two weeks when a non-hemolytic streptococcus was found.

This case was presented—(1) as an unusual instance of extensive chronic villous synovitis with numerous rice-body formations in a young child with definite findings of a pulmonary tuberculous lesion, and (2) because all cultures were negative and only became positive at the end of two weeks.

CHRONIC HYPERTROPHIC VILLOUS SYNOVITIS.

Dr. Henry Milch presented a case of chronic hypertrophic villous synovitis, posttraumatic in origin, showing the early changes originally reported by Hoffa, and now designated as Hoffa's disease.

The patient, a laborer, age thirty-one, gave a history of having injured his left knee, September 9, 1928. Immediately after injury, his knee became swollen, and patient had to be taken home. The usual treatment was instituted, but the swelling persisted. Several weeks later a large amount of fluid was aspirated. There was no history whatsoever of any locking of the knee joint, nor any history suggesting lues in the family. On numerous occasions since September, under minimal trauma, the fluid in the knee joint repeatedly recurred, and each time required aspiration.

When first seen the patient presented the usual picture of hydrops of the knee joint, and walked with a limp, but without any pain. The knee could be flexed to 130 degrees, and extended to 170 degrees. There were no tender areas, no abnormal mobility, and no crepitus on motion. The x-ray of the knee joint showed no evidence of any pathologic condition in the joint surfaces.

The knee joint was aspirated September 14, 1929, 250 cubic centimeters of clear straw-colored fluid being removed, and immediately thereafter a marked coarse crepitus throughout the knee joint could be elicited on motion. September 26, 1929, synovectomy was performed through a median parapatellar incision. Immediately on opening the knee joint a moderate amount of fluid escaped, disclosing a beautiful and typical picture of villous synovitis (Fig. 3). Attached to the surface of the synovial membrane were large and small grape-like clusters of synovial villi floating in the synovial fluid. The synovial membrane was thickened and of yellowish hue, with irregular areas of more acutely inflamed tissue. A typical synovectomy was performed and the knee immobilized on a posterior splint. The patient made an uneventful recovery, and when recently seen showed flexion of 80 degrees, and 180 degrees of extension.

The synovial fluid of the knee joint showed a negative Wassermann test. The gross specimen (Fig. 3), "consists of synovial membrane of the knee joint including the entire quadriceps pouch. It shows very extensive villous synovitis with numerous clusters of very prominent villi. In places the synovia with its surrounding perisynovial tissues measures up to four or five centimeters in thickness. The microscopic section shows typical villous synovitis with thickened synovial folds containing numerous blood vessels and perivascular infiltration of lymphocytes, plasma cells, and monocytes. The culture of the fluid removed is still sterile one week after operation. Diagnosis is chronic villous synovitis."

TUBERCULOSIS OF THE ANKLE JOINT.

Dr. Nicholas Ransohoff presented a case of tuberculosis of the ankle joint. I. S. was admitted to the hospital on December 13, 1927, at which time a diagnosis of chronic arthritis of the left ankle joint was made. Etiology undetermined. He complained of intermittent pain and swelling of the left ankle for the previous eight months. He also complained of pain in the upper portion of his back and in the right axilla. The ankle joint was aspirated and about one cubic centimeter of a clear fluid obtained. This was sent to the laboratory for guinea-pig inoculation. The x-ray report showed a chronic destructive arthritis with atrophy of all of the bones of the tarsus, and a periosteitis of

FIG. 3

Synovial membrane showing grape-like cluster of synovial villi.

the lower end of the tibia. Examination of the lung showed an old calcified tuberculous process of both apices. The man's general condition was only fair.

On December 21, ten cubic centimeters of normal saline was introduced into the joint and reaspirated the next day and sent to the laboratory for investigation. The man was then discharged and sent to Breezy Point for heliotherapy.

He was readmitted to the hospital on February 23, 1928, having shown no improvement, but rather a definite increase in the size of the ankle joint. At this time a diagnosis of tuberculosis of the ankle joint was made. The left ankle joint was three inches larger than the right. There was a shiny appearance to the skin, very slight tenderness, no local heat, and a fluctuating area of one and one-half centimeters on the outer side of the ankle. There was five degrees of motion from the angle of greatest extension, 110 degrees, to the angle of greatest flexion, 105 degrees.

On February 27, the small pouting area on the outer side of the ankle was incised but nothing was obtained. The incision was not carried deeper than the skin.

On February 29, an astragalectomy and resection of the lower end of the tibia and fibula was done. The man made an uneventful recovery. The pathological report shows extensive destruction of the bone with areas of numerous caseous and isolated tubercles in the fibrous tissue.

Diagnosis, tuberculous osteitis.

On March 20, the guinea pig was autopsied and tubercles were found in the liver and spleen.

Current Literature

A Textbook on Orthopaedic Surgery. By Willis C. Campbell, M.D. Philadelphia, W. B. Saunders Company, 1930. $8.50.

"Of the making of books there is no end", and there cannot be if the progress of modern medicine is to be adequately recorded. It is inevitable that in the textbook field there should be repetition of most that has been written before, elsewhere,—perhaps better, perhaps not so well.

The first thing that is new about this book of Dr. Campbell's is its arrangement. More attention than usual has been paid to the grouping of the subjects discussed, and this will advantage the reader. The next feature is the attention directed to operative treatment, with especial reference to arthroplasties, arthrodeses, bone-grafting in tuberculous lesions, and the operative treatment of paralytic deformities and disabilities. Fractures and traumatic dislocations are given a good deal more consideration than ever before in a work on orthopaedic surgery, but osteomyelitis is scarcely mentioned. The principles of fracture treatment are no better set forth here than they are in many textbooks devoted to that subject. If the author had confined himself to those fractures where unfortunate results or non-union had been obtained and corrective measures must needs be adopted, there could have been less criticism of the surgeon whose business it is to "make straight".

Dr. Campbell's skill as an operator guarantees the soundness of his technical recommendations in the operative handling of subjects in which he advocates such treatment, although there may be ground for differences of opinion as to the necessity or desirability of such treatment in certain of the conditions in which it is suggested. In certain of the minor lesions,—*e.g.*, bursitis, thrombo-angiitis obliterans, and hallux rigidus, the author has not been as careful as elsewhere to avail himself of information which would have brought his treatment in line with present-day conceptions.

Dr. Campbell's work in this newer field of up-to-the-minute orthopaedic surgery covers the ground well, and for those with no shackles tying them to the past it will prove a *vade me cum*.

There are many textbooks, but orthopaedic surgeons need most a philosophical discussion of the problems of this specialty.

Chirurgie des Os et des Articulations des Membres. By Prof. P. Lecène, with the collaboration of P. Huet. Paris, Masson et Cie, 1929, 140 fr.

This book is of particular value as it has taken up the surgical treatment of the affections of bones and joints, thus permitting the author to treat in a very clear-cut manner the problems of bone and joint affections from this one point of view. The arrangement of the book is excellent; the subjects are so classified and so grouped that the reader can easily consult it in all the affections and the special treatment for them which is being considered.

The book is divided into eight parts, as follows:

1. The Operative Treatment of Fractures.
2. The Operative Treatment of Osteomyelitis.
3. The Operative Treatment of Tumors and Dystrophic Lesions of Bones.
4. Wounds of Articulations; Arthrotomies; Ankyloses.
5. Surgical Treatment of Tuberculous Osteo-arthritis.
6. Amputations.
7. Resections of Joints and Bones.
8. Surgical Treatment of Osseous Deformities and of the Acquired and Congenital Deformities of Joints.

The author's experiences given in this book are clinical, and not from anatomical studies on the cadaver, and he is therefore able to record in his observations of the living the difficulties encountered in the practice of surgery. However, he also emphasizes the great necessity for the most thorough knowledge of anatomy of joints which is obtained on the cadaver, in order to allow the quick and non-destructive approach, and states that this experience is absolutely necessary for the best form of surgery.

In the portion devoted to fractures, the rules and suggestions of general technique are entered into in detail, and with description and illustration of many of the instruments necessary and convenient to be used in the reduction of the fragments. The special forms of fracture which are difficult to reduce are emphasized in this chapter.

He takes up the question of special consideration of osteomyelitis affecting the different bones, and records his experience in the treatment of this in particular. Acute and chronic osteomyelitis are then considered, and particular attention is paid to the operative treatment of the chronic osteomyelitis, with his opinions in regard to the value of the various methods which have been advocated.

Under the third division is included the bone tumors and bone dystrophies, including osteitis fibrosa. He stresses the consideration of the early detection of the benign and malignant tumors, with special attention given to the differential diagnosis between these two.

In the beginning of the fourth part the author bears testimony to the value of the experience gained during the War, particularly in the treatment of the acute wounds of healthy joints. The various types of wounds, including simple puncture, incised and crush wounds, are described in detail, with the methods of treatment. The methods of approach to special joints will be found particularly valuable, and the descriptions are supplemented by excellent illustrations, which are evidently made to illustrate these approaches from the surgical rather than from the purely anatomical point of view. Particularly should the various approaches to the hip joint be studied.

Less attention is paid to the surgical treatment of tuberculous joints, as would be expected in a book which is confined to the surgical treatment of bones, and in this he has shown a wise conservatism. It is confined practically to the methods of late operation, such as ankylosis of the tuberculous joints, of which the different methods in effect today are well discussed.

The seventh chapter, on the resection of bones and joints, will be found particularly valuable because of the accurate and clear descriptions, supplemented by unusual illustrations which show the various steps in the process, particularly the technique of the approach of sections of the bones. The various operations on the foot are completely discussed and fully illustrated. But little is given in regard to the aftertreatment which is so necessary and prolonged in so many of these joint conditions, but since this work is confined to the surgical treatment this can hardly be regarded as an omission. All surgeons who practise these very important operations on joints and bones are fully acquainted with the need of long continued care.

It is regretted that in this review it is necessary to announce the loss to the profession of the author of this book. Dr. Lecène died last November. He has given to the profession very largely of his valuable experience, and the larger promise of his earlier life for future work cannot now be fulfilled.

SURGICAL DIAGNOSIS (Volumes I and II). By American authors. Edited by Evarts Ambrose Graham, M.D. Philadelphia, W. B. Saunders Company, 1930.

Several chapters in the first volume of Surgical Diagnosis are devoted to subjects of bone and joint affections.

In the chapter dealing with extremities, bones and cartilage, muscle, fascia, tendons, etc., a rather large field is covered in a way to be of very distinct use to the general surgeon and general practitioner, for whom this book is particularly useful. In discussion of these deformities the extreme types are given prominence in the text, which

is of value in emphasizing the need of early care and careful treatment in the prevention of these deformities, although it is the lesser which come more to the general surgeon and to the care of the practitioner. This chapter also includes the consideration of deformities in general, and of those resulting from the diseases of bone,—such as osteitis fibrosa, rickets, chondrodysplasia, and allied affections which may lead to deformity.

In the part devoted to diagnosis of joint disease and injury, a large portion is taken to deal with the general considerations of anatomy in their relation to the function and to the diseases of joints; and also for the discussion of the pathology and examination, which is particularly valuable to those men who have not made a special study of these diseases,—knowledge which is necessary as a foundation for the intelligent treatment of these various conditions. The methods of examination and also the development of the different joint conditions are also treated in detail. Not too large a portion is given to tuberculosis; this large and important subject could have but little attention in a book of this kind. The other affections are also dealt with in detail, and all the important ones are included; they are particularly well illustrated. In diagnosis of tuberculosis of the spine, the differential diagnosis of the various diseases which may be confused with this condition are particularly well considered, and this meets an important demand.

The conditions of the bones which might be called nutritive are grouped under the term "osteopsathyrosis", but the group of malacias, such as are associated with defective calcium metabolism or calcium starvation, are not included. Most excellent illustrations are given of these rather rare but interesting diseases, the knowledge of which is, unfortunately, more confined to the diagnosis and pathology than to the treatment.

The section dealing with the fractures and dislocations of the extremities is divided into two parts, the first devoted to the general consideration of the bones and joints, and the second to the various specific lesions of the different regions, the more important of which are described in detail. A generous portion of the book is devoted to this increasingly important subject. In consideration of the different regions, the anatomy of these joints is described, and the differential diagnoses of the more common lesions to the more important joints are dealt with in detail. There is a general consideration of fractures, their method of causation, as well as the conditions of bone often lending themselves to injury or different types of fractures, and these as applied to special regions. Tables for the differential diagnosis of the more difficult types are also given.

The second volume has the same high standard, but does not contain subjects of orthopaedic bearing.

DIAGNOSE DER BEGINNENDEN KNOCHEN—UND GELENKS TUBER-KULOSE (Diagnosis of Incipient Bone and Joint Tuberculosis). By P. Pitzen. Munich, Otto Gmelen, 1929.

In short and precise diction (text embraces only 108 pages) the author offers an excellent and very exhaustive presentation of the subject. The material is divided into a general and a special section. In the former, after discussion of the general pathogenesis, particular consideration is given to the principles of diagnosis (both clinical and laboratory) and the essential diagnostic features (x-ray, tuberculin, sedimentation, and abscess formation) are critically evaluated.

In the special section, the chapters on tuberculosis of the spine and tuberculosis of the hip seem particularly attractive, both on account of the concise description of the clinical pathology of incipient tuberculosis and also because of the space which is allotted to differential diagnosis.

From the roentgenological aspect, the book is extremely instructive. A number of excellent x-ray plates are appended, featuring the diagnosis of beginning skeletal tuberculosis. Furthermore the x-ray evidence covers not only the osseous changes;

but the soft tissue signs,—such as abscess formation, capsular distention, and so forth, are likewise thoroughly emphasized.

In the concise and yet exhaustive style in which the book is written, it should be of great value to the practitioner as well as the specialist.

TRAUMA, DISEASE AND COMPENSATION. By A. J. Fraser, M.D. (Chief Medical Officer, Workmen's Compensation Board, Winnipeg, Manitoba). The Macmillan Co., Toronto, Canada, 1929. $6.50.

This is a very valuable and timely book for those interested in Traumatic Surgery or in the question of compensatable injuries.

Chapter I gives a good definition of the basis and scope of Workmen's Compensation Acts—"The right to claim compensation is based solely on incapacity, partial or complete, to *earn wages* by reason of personal injury by accident, arising out of and in the course of the employment". "Also, no provision is made for any claim based on pain and suffering endured by injured worker or for sentimental damages." This is very concise, is easily comprehended by all, and should be made known to every workman, employer, and surgeon.

Pages 5-8 contain several definitions of an accident. The best definition is "an unforseen or unexpected event, which takes place without design" (Ruegg, The Workmen's Compensation Board).

Pages 9-19 give many rulings of accidents arising out of and in the course of employment. Dr. Fraser has evidently read widely and we are indebted to him for placing these rulings before us.

The author divides cerebral injuries into four classes:

1. Complete or partial penetration of the wall, as fracture.
2. Contusion by direct contact with a foreign body.
3. Concussion by explosions.
4. Lighter contusions with only temporary phenomena.

He draws attention to the fact that in the acute stage all four groups show the same set of symptoms, but in a short time the true outlines of the picture begin to appear.

It could be wished that he had dealt more fully with this subject, for in his own experiences as a medical officer he must have seen many end results of these cases.

More space might have been devoted to the effect that syphilis plays in cases of trauma, following minor and major injuries, and how these cases should be considered by medical officers of industrial boards.

The many decisions referred to in this work are well worth reading and rereading. With a great number the reviewer does not agree, but the author has compiled and presented them in a very clear, lucid manner; they are very readable and show the rulings of the lay mind in reference to medical matters. He has left nothing to chance and has very carefully gone over many diseases that have very little to do with trauma and he has tried to show any connecting links that may possibly exist, making this book a good book for reference.

The chapter on injury and diseases of the bones and joints is valuable and should be read by every doctor dealing with cases of this type.

On page 305 he quotes Jones-Llewellyn, "An accident may aggravate a local tuberculosis, but to attach responsibility thereto, it is necessary that the exacerbation take place within eight days". This is important and a good guide.

As so many of us have trouble with sacro-iliac joint cases, the chapter on this subject is particularly valuable.

The work very aptly ends with a chapter on occupational, malignant, glandular and infectious diseases, as they affect the workmen.

This work shows extensive reading, good judgment in selection of a timely subject and tries to reason from cause to effect as it applies to the average workman meeting with an alleged accident when at work.

The Journal wishes to acknowledge the receipt of the following books sent to the Editorial Department:

Ortopedia e Traumatologia dell'Apparato Motore. Napoli, Vol. I, No. 4, October 1929.

Norsk Magasin for Laegevidenskapen. Oslo, XCI, Nos. 1 and 2, January and February 1930.

De las Lesiones de los Sesamoideos del Dedo Gordo. By Jesus Riosalido. Published in *Archivos Españoles de Pediatría*, Madrid, May 1929.

Bullettino E Atti della Reale Accademia Medica di Roma. Rome, Vol. LV, No. 11-12, November-December 1929; Vol. LVI, Nos. 1 and 2, January and February 1930.

Giornale Medico dell'Ospedale Civile di Venezia. Venezia, Vol. III, No. 6, December 1929.

Svenska Läkaresällskapets Handlingar. Stockholm, Vol. LV, No. 3, 1929.

* Über die indirekten Brüche des Tibiakopfes nebst Beiträgen zur Röntgenologie des Kniegelenks. By Olle Hultén. *Acta Chirurgica Scandinavica*, Stockholm, Vol. LXVI, Supplement 15, 1929.

Essai sur le Mécanisme de la Destruction Tuberculeuse Ostéo-articulaire (Individualisation d'un nouveau Type anatomo-clinique à Rechutes). By Marcel Galland and Herman de las Casas. Published in *Annales d'Anatomie Pathologique et d'Anatomie Normale Medico-chirurgicale*, Paris, Vol. VI, No. 4, April 1929.

Revista Medica Peruana. Lima, Vol. I, No. 1, December 1929.

Einige Bemerkungen über die Hyperfunktion der Epithelkörperchen. By Prof. W. A. Oppel (Leningrad). Published in *Endokrinologie*, Leipzig, Vol. VI, 1930.

Gazzetta Medica Italo-Argentina. Napoli, Vol. XII, No. 8, May 31, 1929.

Medicina del Trabajo e Higiene Industrial. Madrid, Vol. I, No. 1, January 1930.

*Orthopädie im Kindesalter. By Hofrat Prof. Dr. Hans Spitzy, unter Mitworkung von Gen. Hofrat Prof. Dr. Fritz Lange. Leipzig, F. C. W. Vogel, 1930.

*To be reviewed in a later issue of *The Journal*.

Über Die Behandlung Von Brüchen Des Oberschenkelshaftes (The Treatment of Fractures of the Shaft of the Femur). Gustav Levander. *Acta Chir. Scandinavica*, LXV, Supplement XII, 1929.

Levander has given us an analysis of the treatment of fractures of the shaft of the femur on the basis of 275 cases. The monograph includes an historical and a statistical introduction, the detailed presentation of cases, and a comprehensive discussion and review of the literature. The results obtained by external fixation, skin traction, skeletal traction, and open operation are presented and compared.

Operation is shown to result in a high percentage of disability. It introduces the danger of infection. Even without this, bone union is often delayed and fixation materials must frequently be removed later. Skin traction is decidedly inferior to skeletal extension and inadequate in overcoming shortening. Skeletal traction allows good reposition, fixation, and early motion. It is relatively free from danger. When open operation is necessary to free the fragments from muscle, the same skeletal traction is maintained during and after the operation. Fixation in plaster is used only as a final adjunct. In children up to six or seven years, overhead extension on the skin should give a result with about one to one and a half centimeters of shortening. An increase in the blood supply of the fractured bone results in more rapid growth and an equalization of the shortening. Experiments show that even the unbroken long bones of the leg may show a more rapid growth than on the unaffected side.

Compound fractures are handled by thorough debridement, irrigation with antiseptics, and immediate complete closure.

The monograph is a valuable record of the cases in one locality. The critical comparison of the methods and results with those already published, makes the contribution an important addition to fracture literature.—*W. P. Blount, M.D., Milwaukee, Wis.*

FOERSTER'S OPERATION BEI TORTICOLLIS SPASTICUS (Foerster's Operation in Spasmodic Troticollis). Fritz Kaijser *Acta Chir. Scandinavica*, LXV, 576, Dec. 30, 1929.

A case of severe spasmodic torticollis is reported in which marked improvement was obtained by division of the first three anterior and posterior nerve roots on both sides. To remove the entire innervation of the affected muscles, three anterior roots must be severed. To destroy the sensation at the same level, the cause of reflex spasm, perhaps, it is necessary to cut three posterior roots.—*W. P. Blount, M.D., Milwaukee, Wis.*

ARTHRITIS. Ralph Pemberton. *Am. J. Med. Sciences*, CLXXVIII, 593, Nov. 1929.

This article is an admirable one, summing up our present knowledge of arthritis and correlating the investigations of the author and his coworkers. He complains that while arthritis is the oldest known disease entity, interest and investigation in this field have not kept pace with other fields of medicine.

His discussion of the types, the etiology, and the treatment is most interesting, and the article deserves the careful reading of all men interested in this subject.

CHARCOT'S DISEASE OF BOTH HIP JOINTS. Case Report. L. P. McCalla and A. M. Warren, *Am. J. Roentgenol.*, XXII, 563, Dec. 1929.

A very interesting case is reported with skiagraphs of a patient aged fifty-six, whose left hip suddenly gave way in March 1918. A diagnosis of dislocation was made. One year later the right hip gave way and the same diagnosis was given. Ten years later the patient happened to be in the hospital with a fracture of the patella and while there, with the aid of skiagraphs, the diagnosis of Charcot's disease of both hip joints was made.—*E. S. Hatch, M.D., New Orleans, La.*

OSTEITIS FIBROSA AND ALLIED DISEASES OF BONE (The Osseous Dystrophies). L. H. Garland. *Am. J. Roentgenol.*, XXII, 517, Dec. 1929.

This very interesting and profusely illustrated paper states that the etiology of these conditions is unknown. Pathologically the four conditions are definitely related and differ in degree.

The diagnosis is made on the clinical course and skiagraphs. One set of skiagraphs is often not sufficient for a diagnosis. Thirteen cases are reported.—*E. S. Hatch, M.D., New Orleans, La.*

THE ABSCESS OF POTT'S DISEASE. Ralph K. Ghormley. *Am. J. Roentgenol.*, XXII, 509, Dec. 1929.

This paper is based on a study of a series of films of cases of tuberculosis of the spine from the New England Peabody Home for crippled children, and observations on numerous other cases.

Good skiagraphs reveal many deep abscesses due to Pott's disease which would otherwise go unrecognized. Such abscesses are believed to be the most important complications in tuberculosis of the spine.

In thoracic Pott's disease, the author recognizes three types of abscesses,—fusiform, pyramidal, and globular. The fusiform and pyramidal represent fairly widespread dissection of the spinal column.

The mechanical type of extension is as important as the inflammatory type, in these abscesses. The lumbar abscesses present a different problem, due to the different anatomical structure, and there are fewer vertebrae open to damage from the lumbar abscess whether it be from mechanical or inflammatory extension.

To summarize: Thus we have the most serious menace to life in the abscess of lumber Pott's disease. Its effect on the deformity is of minor importance. On the other hand, the thoracic abscess is a serious menace because of its influence on the deformity, but of less danger to life itself.—*E. S. Hatch, M.D., New Orleans, La.*

La Operacion de Henle en el Tratamiento de la Retraccion Isquemica de Volkmann (Henle's Operation in the Treatment of Volkmann's Ischaemic Contracture). A. Inclan. *Anales de Cirugia* (Habana), p. 9, Oct. 1929.

Dr. Inclan presented to the National Society of Surgery, at Havana, Cuba, the clinical history of two patients treated by Henle's operation for Volkmann's ischaemic contracture, showing the end result of this operation in both cases.

Case 1. O.T., Cuban, twenty years old, suffered while at school, on April 28, a fracture of both bones of the right forearm. Was treated with wooden splints and circular bandage. Rapidly, symptoms of compression developed, with pain, numbness, cyanosis, and swelling of the hand. The bandage was kept on for forty days. When the splints were removed there was a large pressure sore on the anterior surface of the forearm and flexion contracture of both terminal phalanges; marked angular deformity of lower third of radius; forearm maintained in pronation; extension of wrist increasing flexion deformity.

Operation. Resection of diaphysis of radius and ulna, with correction of radial deformity. One inch of each bone was removed. Apposition of fragments was maintained with external plaster splint, hand and fingers in hyperextension and complete supination.

Case 2. L.A., Cuban boy, twelve years old. Fracture of lower third of both bones of right forearm. Treated with double wooden splints and circular bandage for four weeks. Examination at the end of that period showed numerous pressure sores and scars; typical Volkmann's deformity of the hand; wrist in flexion; muscular atrophy with fibrous induration of the anterior forearm muscles; tendency to pronation; marked trophic changes of skin and nails; coldness and sweating of the hand.

Operation. Henle's resection of one inch of the diaphysis of both radius and ulna. Forearm in supination. Hand and fingers in hyperextension in double plaster splint.

Dr. Inclan condemned the use of the rigid wooden splints and circular bandages as emergency treatment for fractures of the limbs. He gave a review of the different treatments for this condition, selecting Jone's conservative treatment with individual aluminum corrective splints in mild cases, and Henle's operative when the deformity is more serious and will not yield to conservative measures.

Both cases showed the correction of deformity and a great improvement of function, although the muscular power remained weaker than that of the normal hand. Supination of the forearm, flexion and extension of the fingers, and some fifteen degrees of hyperextension of the wrist have been obtained in each one of these patients. In each, the hand is entirely useful.

Parathyroidectomy for Ankylosing Polyarthritis. W. A. Oppel. (Leningrad, Russia). Translated by A. S. Kasatchanks. *Ann. Surg.*, XC, 978, Dec. 1929.

The author feels that the arthritis described by Bektereff, with its kyphosis, stiffness, and rigidity, is only quantitatively different from the Strumpell-Marie of definite ankylosis,—that one may become the other. He feels that as a rule a history of scarlet fever, typhoid, spotted fever, osteomyelitis, or gonorrhea may be obtained.

It has been shown that there is a calcium increase in the blood, a reduced electroexcitation of the muscles, and an increased viscosity of the blood in cases of ankylosing arthritis. It was also noted that inorganic phosphorus was increased while the organic phosphorus was normal or slightly increased.

These findings are apparently opposite to tetany, which is assumed to be a hypofunction of the parathyroids, so the ankylosing arthritis was considered a hyperfunction of the epithelial bodies.

Parathyroidectomy under local anaesthesia was done through an incision along the front end of the right sternocleidomastoideus. The inferior thyroid artery was then identified. A parathyroid body usually is present where it enters the thyroid gland. Microscopic examination is necessary, for fifty-five patients were operated upon, thirty-three microscopic examinations made, and in ten no parathyroid tissue was found, although serial sections were not made.

Out of thirty investigations, twenty-seven showed a postoperative reduction in the calcium level. The most striking effect of the operation was the disappearance of the sensation of stiffness.

Samarin, in summarizing the results of forty-nine cases, found no improvement in sixteen, improvement in thirty-three.

If one takes into consideration the fact that in the ankylosing polyarthritis the patient in all probability cannot be cured, the results of this operation are encouraging, in that it primarily destroys the hypercalcaemia, thereby stopping the process of progressive ankylosis; and while the already formed ankylosis remains, it evidently improves the spine.—*C. S. Lowendorf, M.D., Iowa City, Iowa.*

TONSILLECTOMY IN THE PREVENTION AND TREATMENT OF RHEUMATISM. L. Findlay, J. W. MacFarlane, and Mary M. Stevenson. *Arch. Diseases in Childhood.* IV, 313, Oct. 1929.

The authors observed the influence of tonsillectomy and non-tonsillectomy on 153 cases of arthritis and chorea. The results were so confusing and contradictory that no conclusions could be deduced as to the value of this treatment. The effect of tonsillectomy was observed on 108 patients who developed either rheumatism or chorea complicated by carditis. It was found that carditis developed during either the first or second attack of the rheumatic disease. Sixty-two per cent. of patients with both arthritis and chorea developed carditis; in the case of arthritis alone it was forty-three per cent. and in the case of chorea alone, thirty per cent.

It was noted, however, that early tonsillectomy had both a prophylactic and therapeutic effect in the arthritis group, but if done just preceding the onset of arthritis it had little or no effect on the course of the disease or the development of the carditis. In the case of chorea alone, tonsillectomy seemed to have no effect whatsoever, either on the course of the disease or the development of carditis. Tonsillectomy, to be of any value in arthritis, must be done preceding the first or second attack, as all cardiac involvement was found to occur during these early attacks. Carditis develops far more frequently during the arthritic type than during the chorea type of rheumatic infection, and it is in the former type that tonsillectomy is of value.—*Charles L. Hawk, M.D., Iowa City, Iowa.*

TUMORS OF THE CAUDA EQUINA. THE DIFFERENTIAL DIAGNOSIS BETWEEN NEW GROWTHS AND INFLAMMATORY LESIONS OF THE CAUDAL ROOTS. Charles A. Elsberg and Kate Constable. *Arch. Neurol. and Psychiat.*, XXIII, 79, Jan. 1930.

The authors present a clinical analysis of forty-five cases, which they divide into lesions caused by tumors and those of inflammatory origin giving rise to a neuritis. Twenty-eight of these were distinctly tumors, seventeen are recorded as inflammatory. Two were considered tumors of which compression was caused by two enlarged veins in the cauda equina.

Four interesting case reports are given, all of which are characteristic in beginning with lumbago, radiation of the pain down one leg or thigh followed by increasing weakness of the extensors of the legs, sensory disturbances, such as coldness over the buttocks, the feet, and especially over the outer aspects of the legs and thighs, and bladder and bowel disturbances.

The tumors are of intra or extra-dural origin, the latter being rare and arising from the bone or the intervertebral cartilage. The former are intra-arachnoid and may reach one to three centimeters, and then are designated as giant tumors. These are poorly supplied with blood and cause very little bleeding in their removal.

The sex incidence is about equal, the average age for the tumor class being about thirty-two and that for the neuritic about ten years older.

In over half the tumors the pain began unilaterally and then became bilateral. In the neuritic, eighty per cent. began thus and half of these remained unilateral. There was tenderness over the lumbar and sacral spines in sixty-eight per cent., the same

holding true for only twenty-eight per cent. in the neuritic. Muscular wasting was general in the inflammatory, and limited practically to the anterior tibial and peroneal group in the other. Loss or diminution of the tendon reflexes was more consistent in the tumor type. The bladder disturbances were common to both.

In the x-ray there was at times a distinct enlargement of the vertebral canal in the tumor class. The spinal fluid findings in the tumor class are fairly typical, with the xanthochromia and definite increase of total protein. This latter is never seen in the neuritic. The deep orange color is seen in the lower spinal tumors while the higher ones are yellow. The manometric readings are not important differentially because both may show partial or incomplete block. The double lumbar puncture is of value in localizing the tumor. The use of iodized oil is not so accurate in localizing the tumor because it is commonly blocked at a higher level.

A complete work-up of the case is necessary for diagnosis and localization of the lesion for the purpose of laminectomy.—*Jacob Kulowski, M.D., Iowa City, Iowa.*

Über den Metatarsus Varus Congenitus und Seine Behandlung (The Metatarsus Varus Congenitus and Its Treatment). Schulze-Gocht. *Arch. f. Orthop. u. Unfall-Chir.*, XXVII, 443, 1929.

The metatarsus varus congenitus is characterized by the varus position of the metatarsus and the simultaneous valgus position of the tarsus. The skeletal changes involve principally the internal cuneiform bone.

The author believes that the congenital pes adductus is not an independent syndrome, and the difference between the metatarsus varus and the pes adductus is only one of degree, occasioned by the different age period. The metatarsus varus is never the result of a genu valgum, but it is because of the valgus position of the os calcis that occasionally a marked valgus position of the knee is produced. He treats the metatarsus varus along the following principles:

In small children the varus position of the forefoot is manually corrected and the foot is immobilized in corrected position. This procedure is repeated several times, and it is especially important not to increase the valgus position of the tarsus by this manoeuver, but to correct it at the same time. After completion of the plaster-cast period, a night splint with narrow sole and a day brace in corrected position, which takes care of the varity of the forefoot and the valgity of the backfoot, is applied. In older children, beginning from the sixth year the forefoot is first manually corrected over the osteoclast, is put in plaster for two or three weeks in best position of correction, and then an operative step is taken. First, a bone wedge is removed from the outer side of the foot, preserving carefully the insertion of the peroneus brevis, then the first cuneiform is osteotomized from the inner border of the foot in a direction running from proximally inward to distally and outward. The small bony wedge which had been removed from the outer border of the foot is now inserted in the gaping osteotomy cut of the internal cuneiform. After this procedure the foot remains automatically in corrected position. Plaster-of-Paris casts are applied for two or three weeks and the after-treatment consists in the wearing of a leg brace in overcorrected position.

In the last four years the author has observed and treated thirty-six cases of metatarsus varus up to an age of twenty-one years, and in twenty-seven of these cases the deformity was bilateral.—*A. Steindler, M.D., Iowa City, Iowa.*

Die Operation des Angeborenen Schulterblatthochstandes (The Operation of the Congenital Elevation of the Scapula). Felix Flotow. *Arch. f. Orthop. u. Unfall-Chir.*, XXVII, 474, 1929.

Two methods are in the foreground in the treatment of congenital elevation of the scapula. The method of König aims at the best possible physiological mobility of the shoulder blade. In this operation the resection of the scapular muscles from the upper and inner border is avoided, and the scapula is simply divided by a vertical incision parallel to the inner border, then the inner portion of the scapula is pulled down and

fixation is procured by a flap from the upper border of the latissimus dorsi muscle, which is led through the lower and inner angle of the scapula. In this operation the elevation of the outer portion of the scapula is not corrected, but rotatory power of the scapula is established to some degree by the insertion into it of a portion of the latissimus dorsi.

A much better method seems to be that advocated by Putti. The technique of this operation is as follows: after the shoulder blade is exposed by a six-inch incision running along the inner border, all strands and muscular attachments running towards the spine are separated,—this includes the formation of the articulation which is found to run from the upper inner border of the scapula toward the spinous processes. After this is done, it is possible to pull the shoulder blade down. In the lowest position which it is possible to obtain, the shoulder blade is fixed to one or two ribs by means of silk or a bronze wire suture. The author points out that in spite of this fixation to the ribs, the elasticity of the suture still allows rotatory movement of the scapula. He reports on eleven cases operated on by this method, and emphasizes the superiority of Putti's treatment over the method of König. In his cases the operative results were very satisfactory, both from the cosmetic and from the functional point of view.—*A. Steindler, M.D., Iowa City, Iowa.*

DIE DAUERERFOLGE DER PATELLARFRAKTURBEHANDLUNG (Permanent Results of the Treatment of Patellar Fractures). Paul Rostock. *Arch. f. Orthop. u. Unfall-Chir.*, XXVII, 450, 1929.

The article is based on 154 cases, and according to the type of treatment the material is analyzed as follows:

Cerclage (circling suture), sixteen cases.
Wire suture, forty-five cases.
Silk or catgut suture, thirty-eight cases.
Conservative treatment, fifty-one cases.
Various other methods, four cases.
The anatomical results were as follows:
Fibrous union, fifty-three cases.
Bony union, ninety-five cases.
Ankylosis of the knee, six cases.

In this series there were twenty-two cases of compound fractures, eleven secondary sutures, and eight recurrences.

Details of Treatment:

Approaches of Volkmann, Kocher, and others were used, and the author believes that the different approaches give equal satisfaction.

He discusses the suture of the periosteum and of the lateral ligament with silk or catgut. The peripatellar silk or catgut suture gave the following results: bony union in seventy-four per cent., fibrous union in twenty-six per cent., and knee ankylosis in no case.

Considering the wire suture of the patella, no difference is made in the finer details of the methods. In this material, embracing forty-five cases of wire sutures, the author found bony union in sixty-seven per cent., fibrous union in twenty-four per cent., and knee ankylosis in nine per cent. of the cases.

The peripatellar wire suture or cerclage was used by the author in sixteen cases with the following results: bony union in ten cases or sixty-three per cent., fibrous union in four cases or twenty-five per cent., and knee ankylosis in two cases or twelve per cent.

The author thinks that the type of union does not depend on what kind of patellar suture is used and whether or not there is surgical interference. If there is no dislocation of the fragment, conservative treatment is applied. He believes also that the breaking of the wire does not influence the healing, since it occurs long after union is established.

Discussing fibrous and bony union separately, he finds that fibrous union was obtained after conservative treatment in twenty-nine cases or fifty-five per cent., after wire suture in eleven cases or twenty-one per cent., after silk-catgut sutures in eight cases or fifteen per cent., and after cerclage in four cases or seven per cent.; thus giving the conservative treatment the poorest average in regard to anatomical cure.

Discussing the more favorable bony union, the author remarks that the functional result is not always good, and cites von Brunn, who states that it is often the ideal union which shows considerable restriction in motion.

In the author's series, thirty-eight cases or forty per cent. with bony union were returned with full working capacity. There were seven cases of ankylosis of the knee, and this unfavorable outcome was always the result of wound infection. In these cases cerclage had been used twice and wire suture four times.

From the carefully prepared curves in the author's article, one sees that it is of little importance for the working capacity whether fibrous or bony union was obtained, although he points out that bony union is the result one should always try to obtain. In cases of compound fracture the author advises immediate excision of the wound and primary patellar sutures. In eight of his cases recurrences required secondary operations.—*A. Steindler, M.D., Iowa City, Iowa.*

Localization of Bacteria in Tissues of Lowered Resistance. W. Warren Sager and Allen C. Nickel. *Arch. Surg.*, XIX, 1086, Dec. 1929.

Injecting silver nitrate subcutaneously to produce sterile abscesses, the experimenters found they could secondarily infect these areas of lowered resistance by intravenous injections of organisms. The local abscesses yield the same bacteria as those introduced in the blood stream. It is concluded that clean surgical wounds may become infected from some distant endogenous source.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

Fractures of the Transverse Processes of the Lumbar Vertebrae. A Report of Thirty-three Cases. Paul A. Quaintance. *Arch. Surg.*, XIX, 968, Dec. 1929.

After reviewing the literature on fracture of the transverse processes of the lumbar vertebrae, the author reports his observations in thirty-three cases that presented themselves to him. He finds that excessive muscular pull may be an etiologic factor, although external violence is more frequent. In most of the patients the spine was flexed at the time of injury. By far the largest number of processes injured were the second, third, and fourth lumbar vertebrae. Most of the patients with displacement of the fragments had healing with non-union, but in no instance was resection of the fractured process necessary. The period of disability, varying from no loss of time to slightly more than seven months, seemed to be influenced by psychic factors in many instances.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

Bilirubin in Effusions of the Joints. Method of Estimation and Significance. David H. Kling. *Arch. Surg.*, XX, 17, Jan. 1930.

In an effort to help distinguish between inflammatory effusions of the joint and those of traumatic origin, the author has made a study of the bilirubin content. He finds that the icterus index in inflammatory effusion is not lower than in the blood serum, whereas in traumatic effusions the index is raised. A high icterus index in fluid aspirated shortly after the trauma suggests an intra-articular fracture.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

Primary Intramuscular Hemangiomas of Striated Muscle. John S. Davis and Edward A. Kitlowski. *Arch. Surg.*, XX, 39, Jan. 1930.

Primary angiomas of striated muscles may be found in any striated muscle, though they usually affect the lower extremities. They are congenital in origin but grow more rapidly after trauma. They produce pain, swelling, and disability. Two hundred and twelve cases are here collected. Excision offers an excellent prognosis.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

FOCAL INFECTION IN SPONDYLITIS DEFORMANS. I. William Nachlas. *Arch. Surg.*, XX, 159, Jan. 1930.

To substantiate his impression that spondylitis deformans of the von Bechterew and the Marie-Strumpel types do not respond favorably to the removal of foci of infection, Nachlas surveyed all such cases on record at the Johns Hopkins Hospital, in which a focal search and eradication were used. None of the fifty-six patients studied presented any improvement whatsoever, as a result of such treatment. On the other hand, attention to orthopaedic consideration, such as the prevention of deformities, yielded the most satisfactory results.

A FURTHER NOTE ON KÜMMELL'S DISEASE. J. Cardis, G. F. Walker, and R. H. Oliver. *British J. Surg.*, XVII, 319, Oct. 1929

As a sequel to their previous article the authors present a photograph of the pathological specimen of a proven case of Kümmell's disease. They emphasize the salient features of the malady as:

1. An injury, direct or indirect, grave or trifling, to a vertebral body.
2. A period of disability according to the gravity of the trauma.
3. A latent period.
4. A recurrence of local pain and severe disability due to
5. A crumbling collapse of a selected vertebral body and its assumption of a wedge shape as seen in sagittal section.
6. The arrest of the process by orthopaedic support. The authors' points are well emphasized and supported.—*L. J. Miltner, M.D., Iowa City, Iowa.*

CONGENITAL DISLOCATION OF THE HIP; WITH SPECIAL REFERENCE TO THE ANATOMY. H. A. T. Fairbank. *British J. Surg.*, XVII, 380, Jan. 1930.

The anatomy of the normal hip and the dislocated hip is discussed. The article is illustrated with excellent cuts. The chief feature of the foetal congenital hip lies in the poor development of the upper margin of the acetabulum. The secondary abnormalities are the slight displacement of the head, slight laxity of the capsule and the cartilaginous margin of the acetabulum. Later, as the anterosuperior and the posterior boundaries continue to grow, unchecked by the pressure of the head of the femur, the acetabulum becomes triangular-shaped, with the apex upward and backward. The cavity of the acetabulum may be surprisingly deep, but there is a thick layer of cartilage on the floor. The obturator foramen is more triangular than normal; the pubic angle is increased, and the anterior inferior spine is twisted to conform to a shorter and broader ilium with prolongation of the anterior border in a vertical line. In addition there is usually a false acetabulum which is a shallow, circular pond, larger than the head of the femur in some instances. In many specimens there was no margin to the false acetabulum. The bone behind the acetabulum may show marked roughening in some instances where there is no false acetabulum, presumably due to free motion of the head behind the normal socket, made possible by the extreme posterior attachment of the capsule.

The author emphasizes the importance of the ischiocapsular band which forms a sling over the neck of the femur. The muscles which assist the capsule in slinging the pelvis on the femur are the psoas in front and the obturators and their associates behind. Factors which may contribute toward the production of the characteristic gait, and the causation of the pain experienced in later life are discussed. The various operative procedures at our disposal have been criticized in the light of the stated facts and theories.

Early treatment of all congenital hips is advised. If treated early in childhood manipulation is often satisfactory, but nearly all reductions should be successful by open operation. For the relief of pain in the adult, previously untreated, the author advises arthrodesis except in a few selected cases where osteotomy is satisfactory.

THE BEAUFORT ARTIFICIAL LIMB WITH RECENT MODIFICATIONS. Charles W. Cathcart. *British Med. J.*, II, 754, 1929.

Cathcart describes a crude artificial limb for above-knee amputation devised in 1851 by Count Beaufort. It can be made by any carpenter. It consists of two lateral-shaped bars of wood hinged at the knee; at the top they are connected by a padded half ring of iron, completed in front by a strap. A solid foot is attached. Its virtues seem to be its cheapness and simplicity of manufacture.—*R. I. Harris, M.D., Toronto, Canada.*

THE TREATMENT OF SCOLIOSIS. D. McCrae Aitken. *British Med. J.*, II, 939, 1929.

Dr. Aitken opened the discussion on the above subject before the section on orthopaedics of the British Medical Association. In his opinion the most important basic element in the deformity is the rotation. He regards the lateral curvature as secondary to this. Behind the deformity and causing it he considers there to be disturbances of postural reflexes which result in asymmetric posture and breathing. He considers the latter of particular importance. He divides treatment into three groups:

1. Exercises and training in posture and balance. This method comes first and last and all the time.
2. Assisting postural exercises by twisting the trunk into a more correct position and retaining it by means of splints and jackets while the postural reflexes are trained.
3. Operative methods of treatment.

He has had no experience with operative methods even in paralytic cases, which he treats with jackets. He has devoted himself entirely to treatment by means of corrective jackets and corrective exercises. He makes acknowledgments to the teaching of Hoke and of Abbot. One gathers that even after the long study Dr. Aitken has obviously given this subject, his results are not always happy.—*R. I. Harris, M.D., Toronto, Canada.*

BEITRÄGE ZUR KONSERVATIVEN BEHANDLUNG DER FRISCHEN KNIESCHEIBENBRÜCHE (Contributions to the Conservative Treatment of Fresh Fractures of the Patella). H. Kalenscher. *Bruns' Beitr. z. klin. Chir.*, CXLVI, 460, 1929.

The author reports nine cases with adequate follow-up on eight. Of these, six displayed normal function. One could flex ninety degrees and one but forty-five degrees. Six could ascend steps in normal fashion. Seven showed joint crepitation on examination. Four observed pains with change of weather. Of the nine, seven obtained bony union.

The treatment employed consisted of early immobilization in an elevated long leg splint. Pressure bandages were employed to hasten absorption of the hemarthrosis. If absorption was delayed within eight days after injury, the joint was punctured and subjected to irrigation with three per cent. carbolic acid solution. Thereafter the fragments were normally approximated and held so by a compression bandage. To avoid quadriceps atrophy, massage was instituted at the end of the first week. The average duration of treatment was fifty and three-tenths days in these conservatively treated cases, compared to forty-five and five-tenths for the operative reduction of similar fractures.

It is the opinion of the author that conservative treatment should be employed when manual reposition is sufficient to obtain reduction of the fragments. The importance of early massage is stressed.—*J. E. Milgram, M.D., Iowa City, Iowa.*

VERSUCHE ZUR ERKLÄRUNG DER SPÄTRUPTUR DER LANGEN DAUMENSTRECKSEHNE NACH RADIUSFRAKTUR (Attempts to explain Delayed Ruptures of the Extensor Pollicis Longus after Fracture of the Radius). Karl Kleinschmidt. *Bruns' Beitr. z. klin, Chir.*, CXLVI, 530, 1929.

Since 1876, when Duplay first described the syndrome, twenty-five cases have been reported in the literature. At operations reported, all of which have been a considerable time after the initial trauma, shredded tendon stumps have been found lying in a

smooth tendon sheath. It had been suggested that the tendon is injured at its point of angulation in the dorsal carpal ligament. On the basis of fifteen experimentally induced fractures on fresh cadavera, Kleinschmidt, however, offers the hypothesis that at the time of fracture a split appears in the radius between five and twelve millimeters from the end of the bone. The tendon sheath of the extensor pollicis longus, peculiarly enough, was the only extensor sheath to regularly tear corresponding to radial fracture. It is the suggestion of the author that too early movement, say within the first ten days after fracture, may result in trauma to the tendon as it moves over the sharp bone gap. The gap will be repaired, but the tendon injury resulting may be such as to induce disintegration with consequent rupture. It is of interest to learn that he has regularly found loud crepetation on auscultation over the wrist on contraction of the thumb extensor in fresh fractures.—*J. E. Milgram, M.D., Iowa City, Iowa.*

PSEUDOLUXATIO COXAE DURCH ABREISSEN DER FEMUREPIPHYSE BEI DER GEBURT (Pseudodislocation of the Hip as a Result of Avulsion of the Femoral Epiphysis at Birth). R. J. Harrenstein. *Bruns' Beitr. z. klin. Chir.*, CXLVI, 592, 1929.

The author reports two cases in which the upper femoral epiphysis, compressing the head, neck, and greater trochanter, was severed from the shaft. It forms a syndrome which can be easily confused with congenital dislocation of the hip, as, until the tenth month, no ossification appears in the head, and its location cannot be determined by x-ray. Early palpation is inaccurate because of the swelling. Harm may be done by attempted reduction of these hips in which the head is really not at all dislocated.

The limb assumed the position of adduction and flexion, because the muscles attached to the neck and greater trochanter lost their effect on the shaft as a result of the separation of the epiphysis. Consequently the adductor muscles, their antagonists, executed their action unopposed. The proximal end of the diaphysis slid laterally as the lower end of the shaft adducted.

Experiments on new-born infants showed that this separation could be readily produced by rotatory movements of the femur followed by forced hyperextension. In the latter position the head locked against the iliofemoral ligament and the epiphysis was felt to gently slide off the diaphysis. There was no sound or sensation which would have made the operator conscious of the production of a fracture. The periosteum remained intact as a rule in most areas. Healing in the coxa vara position with some excess callus appeared in the author's positions.

The author believes that if the diagnosis can be made, treatment by extension applied to the femur, as in fractures of the shaft in infants, may ensure the epiphysis reattaching itself in its normal relationship to the diaphysis.

The article is well illustrated.—*J. E. Milgram, M.D., Iowa City, Iowa.*

VERSUCHE ÜBER GESTIELTE KNORPELFUGENÜBERPFLANZUNGEN (Investigations Concerning the Pedunculated Transplantation of Cartilage). K. Reschke. *Bruns' Beitr. z. klin. Chir.*, CXLVI, 713, 1929.

It has been the common experience of those who have performed homotransplantation of cartilage that even under favorable circumstances only the peripheral layers of the cartilage mass retained normally stained cells.

In autotransplantation, epiphyseal discs were reported by Hellor to remain viable and grow in their new position. Others have shown that when bone surrounds the cartilage transplant, the cartilage does not survive, probably because the bone cuts off the nutrition of the cartilage.

In the experiments reported, the author removed the skin from the upper extremities of young, growing guinea pigs, amputated the paw in each case and inserted the arm under the skin of the abdomen, so that the lower portion of the humerus and the elbow joint were located in this new position. Healing in this position regularly followed. Then at chosen intervals in different animals the limb was severed, so that the central blood supply to the transplanted humerus was gone. On later study it was

observed that of those preparations whose connection with the central vascular systems had been severed in twelve days only twenty-five per cent. showed some retention of cartilage in the lower ulnar and radial epiphyses, while 100 per cent. of those severed after four weeks were satisfactory. In other words, the sooner the pedicles are severed and the less the nourishment obtained from the soft parts, the more the homoplants resemble the results of experimental autotransplantation of cartilage surrounded by bone. Apparently four weeks is the minimum time in which pedicle transplantation of growing cartilage can be performed with the assurance of continued viability.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Ein Fall von schnappender Hüfte im ersten Lebensjahre (A Case of Snapping Hips in the First Year of Life). H. Hilgenreiner. *Bruns' Beitr. z. klin. Chir.*, CXLVII, Heft 2, 210, 1929.

The mother of an infant aged eleven and a half months sought advice in regard to an audible snap which seemed to originate in the infant's left hip. This appeared often while child was in bed or the bath. On examination it was found that the child subluxated the anteverted head over the posterior acetabular ledge. A restriction of abduction was present. Palpation gave no evidence of a slipping of the tensor fascia lata over the greater trochanter, nor did there appear to exist any abnormal formation of the latter.

As far as therapy is concerned, the author recommends treating the condition simply as a luxation,—*i.e.*, the use of an abduction splint. Braune had occasion to operate upon a seventeen-year-old female with a similar complaint, and found a defect in the cartilage deepening the acetabular ledge.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Über das schnellende Knie (Concerning the Snapping Knee). H. Margulies. *Bruns' Beitr. z. klin. Chir.*, CXLVII, Heft 2, 217, 1929.

The author reports habitual spontaneous dislocation of the external semilunar cartilage of the knee in a healthy female of eight years. No history of trauma existed. Flexion of the knee was regularly followed by an audible snap and a visible movement in the area of the external semilunar cartilage. At operation there appeared a normal semilunar attached in normal fashion to a very relaxed external lateral ligament. On reaching 165 degrees of flexion, the ligament and cartilage could be seen to slip medially each time and catch between the opposing joint surfaces. Removal of the cartilage was followed by restitution to normal in two months.

The author confirms abnormal laxity of the external lateral ligament as a cause of dislocation of the external semilunar cartilage. He observes that testing the tension of this ligament with the knee fully extended is open to criticism, inasmuch as the other structures of the knee maintain this most stable position of the joint. He advises examination in mild flexion.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Zur Frage des vollständigen plastischen Ersatzes der Kreuzbänder des Kniegelenks (A Contribution to the Plastic Replacement of the Crucial Ligaments of the Knee Joint). Joroschy. *Bruns' Beitr. z. klin. Chir.*, CXLVII, Heft 2, 233, 1929.

The author reports two cases of operative replacement of the crucial ligaments by free fascial transplants. In one case, a man of twenty-nine, the anterior crucial ligament had been ruptured four years previously. In the second, a laborer of thirty-seven, the posterior crucial ligament was freshly avulsed from the femur. Instability was the complaint requiring operation. Stability and full range of motion were obtained in each case.

The method of Alwyn Smith was used, the knee incision, however, being S-shaped and the ligamentum patellae not being divided; nor was silk used in forming the new crucial as in the modification of Gold.

The author remarks that not all crucial ligament ruptures are followed by instability. He recounts the history of a young female operated on for meniscus lockage, in whom a ruptured anterior crucial ligament was found. The knee, before and after operation, was quite stable. Furthermore, in his cases the rupture of the crucial ligament was not demonstrated to have accompanied injury of the lateral ligaments of the knee.—*J. E. Milgram, M.D., Iowa City, Iowa.*

FRACTURE OF THE PELVIS. M. C. Harding. *California and West. Med.*, XXXI, 320, Nov. 1929.

The author reports the results of treatment in 127 cases of fracture of the pelvis, eighty-seven cases of multiple and forty of single fracture. Mortality in all cases, eight per cent. Five had ruptured bladders, of whom three died; one had a ruptured urethra, and survived.

In complete break of the pelvic ring the author emphasizes the importance of first determining the condition of the bladder. In these cases the force released by the breaking in front is spent on the sacro-iliac joints posteriorly, and it is to this region we should look in making our prognosis. The disability in these cases following complete break of the girdle was limited to pain in the groin near the adductor attachments or in the low back. The first is accounted for by muscle pull on callus; the second by strain of the sacro-iliac attachments. To avoid this the author advocates treatment of these cases by suspension in a canvas sling which is suspended from an over-bed frame, and through pulleys is controlled by a ratchet at the foot. The sling encircles the pelvis and should leave about one-half of the patient's weight on the bed. This is continued for five weeks, and is followed by a sacro-iliac belt, which is worn in bed for one week, and then the patient is allowed up. Weight-bearing is prohibited until there is absence of pain.—*Leonard Barnard, M.D., Iowa City, Iowa.*

STENOSING TENDOVAGINITIS OF DE QUERVAIN. Report of a Case. James T. Watkins and Horace C. Pitkin. *California and West. Med.*, XXXII, 101, Feb. 1930.

This is a disease affecting the sheath of the abductor and extensor tendons of the thumb where they pass over the radial styloid. There is a constriction of the sheath, giving rise to tenderness, swelling, and disability in this region.

The patients are usually women whose work requires the use of their hands. The onset is gradual, and sometimes with a history of mild repeated trauma. Roentgen-ray examination may show calcification of the affected tendons.

Treatment consists in immobilization for six or eight weeks. If not relieved by that time, the tendon sheath should be opened by incision and not resutured. About seventy per cent. get well without operation, and ninety per cent. with operation.

One case is reported: Pain and swelling over left radial styloid of a man, following a rather severe crushing injury. The roentgen-ray showed no fracture. Seen a month later, he showed a localized swelling over the lower end of the radius the size of a half-dollar, firm, slightly tender, apparently attached to the bone. X-ray showed irregular ossification over the radius. Physiotherapy was tried for ten days, but only slight improvement was noticed. At operation the annular ligament was found very much thickened, and contained calcified sheets. The tendon sheaths were opened and some irregular bone removed from the main shaft. Postoperative treatment consisted of early motion, and the patient was discharged cured after about five weeks.—*William Arthur Clark, M.D., Pasadena, Calif.*

INNESTI OMOPLASTICI DI CALLO OSSEO NELLO SCHELETRO (Homoplastic Transplant of Bone Callus in the Skeleton). G. M. Antonioli. *Chir. d. Org. di Movimento*, XIII, 559, July 1929.

The experiments were carried out on guinea pigs. The author concludes that in bone fracture, the graft, implanted homoplastically, is able to survive and to attach itself fully within the time of forty days. This is the longest time in which the graft remained distinctly recognizable in the author's experiments. The trabeculae of the osteoid tissue, appearing in greater or lesser quantity within a groundwork of rich granulation tissue, survive almost completely, and in all histological actions they were found well preserved and offered perfect sustaining qualities.

The group of the cartilage cells is found variously abundant and disseminated within the callus,—that is, either interspersed in the connective tissue, or lying within the walls of the osteoid trabeculae. These cells offer greater variation in their state of

conservation. In all stages groups of cells in perfect conservation may be found together with other groups in which dissolution and re-absorption are more or less advanced. In most of the implants it was found that the quantity of well preserved cartilage cells was a good deal greater than of those found in process of degeneration. This fact causes the author to believe that the small islands of these cells depend partly upon the trauma induced by the operative procedure and partly upon the degree of inflammatory reaction of the host tissue. In fact, the gravest retrogressive changes are observed in cartilage groups arranged toward the surface of the graft, and the intensity of necrosis was the more manifest the more intense the inflammatory reaction of the neighborhood had been. In no instance was there observed mytosis or other signs of proliferation on the part of the cartilage itself. The author's investigation seems to conform to the idea that the fate of the implanted part depends, aside from the conditions of nutrition of the surroundings, particularly upon the degree of usefulness and capacity of the regeneration of the implanted tissue. In short, results show that the homoplastic implant into the skeleton has a decided tendency toward survival and fusion.—*A. Steindler, M.D., Iowa City, Iowa.*

L'Epicondilite Femorale (Femoral Epicondylitis). Antonio Merlini. *Chir. d. org. di Movimento,* XIII, 573, July 1929.

Observation was made of a case involving a man of twenty-one. The examination of the lower extremities revealed moderate swelling of the soft parts in the internal aspect of the knee. There was spontaneous pain, slight and discontinuous, especially when the patient was standing on his legs for a length of time, and there was very marked pressure pain over the epicondyle and the neighboring portions of the condyle. The roentgenogram was negative. The case was considered one of epicondylitis of the femur, a condition which is not infrequent and has nothing to do with rickets, syphilis, or tuberculosis, nor with acute trauma. This type is also not to be classed with Osgood-Schlatter's disease, as some of the authors have indicated. Roentgenologically, epicondylitis offers an entirely negative finding. The author interprets his case rather as a hyperplastic ossifying periostitis such as is produced by static factors, especially the effect of the slight valgus of the knee. He believes that it is quite likely that there may be a coexisting inflammation of the bursa anserina as well as the bursa mucosa of the muscular semimembranosus. All the other bursae about the knee are too remote posteriorly.

Of particular importance is the differential diagnosis between this condition and the so called Stiedas fracture, a fracture of the epicondyle with subsequent ossification. In all cases of this kind, however, there is the history of definite trauma, either direct or indirect. Indirect trauma to the inner side of the knee produces the evulsion of the tendon or the sheering off of the tubercle of the adductor magnus, or the lesion of the internal lateral ligament, or of the epicondyle with partial fracture. Also, there is always a considerable hematoma. Indirect trauma produces either a fracture of the epicondyle or a contusion of the capsular ligamentous apparatus with extensive effusion. In either event there is a single and violent trauma, distinct pain, functional disability, swelling and hemarthrosis. Also, the radiogram in these cases shows positive evidence of a fragment. All these points differentiate the condition from the epicondylitis of the femur in which no x-ray evidence is at hand, nor is there a single but rather a continuous and persistent mechanical factor at work.

The treatment is conservative: rest and physiotherapy. In the latter direction especially, diathermy and radiotherapy have proven useful.—*A. Steindler, M.D., Iowa City, Iowa.*

Lussazione Centrale del Femore (Central Dislocation of the Femur). P. Pieraccini. *Chir. d. org. di Movimento,* XIII, 615, July 1929.

The author reports three cases. Following Chiarugi, he adopts the following subdivisions: (1) Central dislocation of the femur with only the displacement of the

floor of the acetabulum; (2) Central dislocation of the femur with displacement of the acetabulum and concomitant fracture of the pelvic bone. The former is called a pure or simple dislocation; the other, a complex one.

All three cases presented by the author were those of central dislocation of the femur together with fracture of the pelvis, all belonging, therefore, to the second subdivision. This dislocation is produced when the individual falls from a certain height, striking the trochanteric region, or when a heavy weight strikes this region while the pelvis is fixed. As to the position in which the thigh must be at the moment of the accident in order to produce this injury, the opinions are divided. Some believe it is adduction and inward rotation; others, abduction and outward rotation. Certain experiments carried out along these lines have not been able to clear the question. It is certain, however, that the central dislocation of the femur requires a very violent trauma against the trochanteric region, which causes a displacement of the acetabulum through the pressure of the femoral head.

The central dislocation of the femur may be associated with two principal types of fracture of the pelvic ring,—namely, separation of the symphysis and the sacro-iliac articulations, and the fracture of the anterolateral or posterolateral quadrant of the pelvic ring. The greatest displacement occurs in the floor of the acetabulum. In general, the other fractured bones remain in fairly good position to each other. The characteristic signs of displacement of the acetabulum and penetration of the epiphysis of the femur are: ecchymosis, effusion into the scrotum of the traumatized side, swelling and infiltration, painfulness to touch of the small pelvis revealed upon rectal examination, shortening of the distance between symphysis and the superior margin of the greater trochanter, palpation of the femoral head, iliac fossa and the position of the limb after the trauma. However, none of these, and especially the latter ones, are always ascertainable at the time of injury. There is further the change of landmarks in Roser-Nelaton's line, and the changes in measurements in Bryant's triangle.

When a simple central dislocation is at hand, any of these may be ascertained at the time of injury and the diagnosis made, especially that of the absence of fracture of the pelvis. In many cases, however, a proper diagnosis of the central dislocation cannot be made until the x-ray picture is taken.

Treatment. The treatment consists in longitudinal and lateral traction, which Putti also recommends as the manoeuver of reduction. All these cases described by the author belong to the central dislocation with interpelvic displacement of the femoral head. In all these traction was applied. This traction must be followed by painstaking immobilization.

Operative methods which have been attempted from time to time have not given satisfactory results.—*A. Steindler, M.D., Iowa City, Iowa.*

La Frattura dell' Eminenza Capitata dell' Omero (Fracture of the Eminentia Capitate of the Humerus). S. Ciaccia. *Chir. d. Org. di Movimento,* XIV, 181, 1929.

Three cases are reported and two types are distinguished,—the partial fracture of the tip of the eminentia of the type of Kocher-Lorenz, and a total fracture of the type of Hahn-Steinthal.

The former,—that is, the partial fracture—is less frequent, the fragment being constituted solely of the cartilaginous shell of the eminentia with very little bony substance, so that it amounts only to a peeling off of the process. The small fragments remain attached to the humerus by means of periosteal bands, or else become free and form an interarticular body. Two of the author's cases were of this type. The third case was of the type of Hahn-Steinthal, representing a total fracture. In all cases the fragments were displaced upward and forward. There is, in the partial type, only slight swelling and suffusion. Usually there is pain upon pressure at the site of the eminence and over the head of the radius. The functional disturbances of the elbow are, as a rule, not particularly grave, and often the patient continues to work. In the two cases of the author, however, the functional disability was complete, so much so

that the involved limb became absolutely fixed in almost extended position of the forearm and in semipronation. Valgism occurs but it is inconstant, as is also crepitation of the fragments in pronatory and supinatory movement at the head of the radius. As far as the disturbance of the mobility is concerned, there is always a certain limitation of flexion or extension, although the degree of restriction varies greatly. Naturally the limitation of flexion is greater than that of extension in those cases in which the fragments are displaced forward and upward, whereas extension is limited in cases in which the displacement occurs backward. In inveterate fractures the diagnosis is usually easier. The limitation of motion is more or less marked in the direction of extension or flexion, and the fragment which has become re-attached to the humerus is easily palpable.

Some of the authors attach a certain importance to the age of the patient, and it is maintained that the fracture does not occur before the fifteenth year, since only then the epiphyseal nucleus of the eminentia is fused with the diaphysis. In the epoch from the fourteenth to the twenty-second year, the partial or Kocher-Lorenz type is the rule according to the author, whereas in older individuals, from thirty-eight to fifty-three years of age, the total or the Hahn-Steinthal variety is much more common.

Of interest are the mechanics of this injury. It may occur following a fall with hand and forearm extended, or with elbow flexed and the limb abducted. In the first case, the blow is transmitted indirectly to the eminentia by means of the radius, especially if the forearm is not completely extended. In this position the joint surface of the radius sheers against the internal surface of the eminentia capitate so that the fragment becomes displaced backward and upward.

According to Clavelin, the mechanism of the deformity is different if the fall occurs with the elbow flexed and the limb abducted. In this instance, owing to the pressure of the olecranon upon the trochlea, not only a complete detachment of the epiphysis of the eminentia occurs, but the fragment includes, also, a more or less extended portion of the trochlea.

Treatment: All observers are agreed that the proper treatment consists of surgical intervention and removal of the osseous fragment. Only Bastianelli found it opportune, in one of his cases, to resect the inferior extremity of the humerus because of the formative changes which had occurred. If the fragment is displaced forward and upward but still occupies the external half of the anterior surface of the humerus, the anteroexternal incision is made; on the other hand, in displacement backward, the posterolateral incision is preferable. Removal of the fragment usually gives complete functional restoration.—*A. Steindler, M.D., Iowa City, Iowa.*

STUDIO STATISTICO SULLA LUSSAZIONE CONGENITA DELL' ANCA (Statistical Study of Congenital Dislocation of the Hip). F. Mandruzzato. *Chir. d. Org. di Movimento,* XIV, 200, Oct. 1929.

The material observed in the Istituto Rizzoli, Bologna, embraces 2578 cases or 3685 dislocations, seen in the period from 1899 to 1927. Of these patients eighty-five per cent. were female and fifteen per cent. were male; forty-three per cent. were bilateral and fifty-seven per cent. unilateral dislocations. Of 1471 unilateral, 908 were of the right side and 563 were on the left.

The author gives the following data regarding heredity and birth. Of 2276 dislocations, 502 or twenty-two per cent. had some relative or some member of the family affected with the same deformity. Direct hereditary influence was found in six and one-half per cent. of the cases, familial influence in seventeen per cent. As to the influence of birth, of 2297 cases in which a birth history was given, only 265or eleven and one-half per cent. had a history of birth complications, whereas in eighty-eight and one-half per cent birth was normal. One must compare this, however, with the fact that among 1000 births, sixty are abnormal, so that the percentage of abnormality exceeds only very little the normal percentage of anomalous births. Only in seventy-five (or three per cent.) of the patients, other congenital malformations were manifest.

The time at which diagnosis was made is of special interest. Among 2482 children in whom sufficient anamnestic data could be obtained, the deformity was observed at the first steps in 2195 or eighty-eight and one-half per cent; in 125 or five per cent. within the first five years and only in twenty-seven or one per cent. beyond five years of age. Only in two per cent. of the cases, diagnosis was made in the first twelve months, and in forty-seven per cent. from the first to the third year. However, in later years conditions have changed very much in favor of early diagnosis. Whereas, before 1920 the children were very rarely brought for treatment in the first twelve months, the number of these cases has increased steadily in the last seven years.

Treatment: Bloodless reduction with the Paci-Lorenz method was carried out in 2212 cases, or eighty-eight and one-half per cent. Open reduction was carried out in seventy-nine cases or three per cent. In 132 cases or five per cent. the treatment was palliative and in seventy-eight cases no treatment was instituted for diverse reasons.

The author especially notes the occurrence of subluxation, giving statistics dating after 1921. From that time until 1927 there were, among 1122 dislocations, 157 cases or fourteen per cent. of subluxation. The ratio of subluxation between male and female patients was about the same as that of dislocations, namely, eighty-seven per cent. in women and thirteen per cent. in men. Forty-three per cent. of the subluxations were bilateral; thirty-six per cent. of the subluxations were right (against thirty-nine per cent. right side dislocations) and forty-seven per cent. of the subluxations were left (against twenty-two per cent. left side dislocations).

As to the regional distribution of the dislocations, the author quotes Le Damany who gives the percentage of dislocation as four to a thousand, or one to 262 individuals. The percentage for Northern Italy is given by the author as about the same, namely, 4.65 per thousand. He finds that the percentage of incidence is higher in thickly populated localities in the plains and at concentration points of commercial routes, which is probably responsible for better intermingling of heterogenous stock.—*A. Steindler, M.D., Iowa City, Iowa.*

THE PREVENTION OF DEFORMITIES IN CHRONIC ARTHRITIS. I. The Upper Extremity-Loring T. Swaim and John G. Kuhns. *J. Am. Med. Assn.*, XCIII, 1853, Dec. 14, 1929.

Deformity following arthritis is the most serious phase of the disease so far as the patient is concerned. It is also the most important economic feature, there being more people on pensions in Sweden as the result of these deformities than from tuberculosis. Immediate care should be exercised as to the best functional position of the various joints and they should be held in this position, especially at night. This should, of course, not limit active motion of the involved joints.

The shoulder: The optimal position for an involved shoulder is in abduction and external rotation, as fewer adhesions are liable to form and less limitation of motion occur. Therefore, the carrying of the arm in a sling is advised against.

The elbow: At night a splint holding joint in full extension should be used and during day free motion allowed, the tendency here being for flexion and pronation of forearm deformities to occur. The optimal position in case of a stiff joint is not ninety degrees flexion, but just enough flexion to permit the hand to reach the face.

Wrist and hand: Prevention of deformities here is done by the use of cock-up splints.

Fingers: Forward extensions from cock-up splint should be used, and an opposition check for thumb at night.—*P. M. Girard, M.D., Dallas, Texas.*

THE PRESENT STATUS OF CONVALESCENT SERUM THERAPY. W. H. Kellogg. *J. Am. Med. Assn.*, XCIII, 1927, Dec. 21, 1929.

Of the convalescent serums that have been used in the treatment of diseases, only two deserve to be mentioned: those for measles and poliomyelitis.

Measles: Serum here is useful only in prevention, not as a curative. Dose for a

three-year-old child is six cubic centimeters, and up to ten cubic centimeters for an older child. In the few cases in which disease is not prevented, disease is usually very mild and uncomplicated.

Poliomyelitis: Serum treatment is still in the experimental stage. There is definite evidence in monkey experiments that the serum is of definite prophylactic value. This is not true of curative measures. However, monkey experiments tend to show it has some curative value when given before the onset of paralysis.

Some experimental figures from the University of Manitoba, Canada: number of cases treated, 161.

Group 1: One dose of serum given intramuscularly in preparalytic stage in fifty-seven cases. Complete recovery, ninety-three per cent.; residual paralysis, seven per cent.; deaths, none.

Group 2: Seventeen patients received two or more doses given in preparalytic stage, with complete recovery, ninety-four per cent.; residual paralysis, six per cent.; deaths, none.

Group 3: Thirty-three cases. Serum given after onset of paralysis. Complete recovery, twenty-two per cent.; residual paralysis, forty-five per cent.; deaths, thirty-three per cent.

Group 4: Fifty-four cases. Serum not given. Complete recovery, twenty-six per cent.; residual paralysis, sixty-three per cent.; deaths, eleven per cent.

It is noticed that the group receiving serum after onset of paralysis had a mortality rate three times as high as the group not receiving serum. The best method of giving serum—intramuscularly, intravenously, or intraspinally—is still in question.

The conclusions are that the best method of administration is intrathecally or intramuscularly and that if serum is used, it should be given during preparalytic stage.—*W. B. Carrell, M.D., Dallas, Texas.*

Dislocations of the Cervical Vertebrae. Report of Thirty Cases. Mitchell Langworthy. *J. Am. Med. Assn.*, XCIV, 86, Jan. 11, 1930.

Thirty cases, seen in nine years, are reported.

Dislocation occurs by upward displacement of rib. Method of Walton is used in reduction,—this aims at replacing dislocated rib facet. To reduce a left rib, head is pulled to right side to dislodge facet; then head is rotated to left to throw upper facet backward and down to fit lower facet. A plaster cast is applied, including head, neck, and chest, with the head in hyperextension.—*P. M. Girard, M.D., Dallas, Texas.*

Fractures of the Hip. C. E. Ruth and V. A. Ruth. *J. Am. Med. Assn.*, XCIV, 169, Jan. 18, 1930.

Diagnosis should always be made with x-ray. This also gives information as to how reduction should be done. Frequent x-ray checks should be made to be sure position is being maintained.

1. Fractures of head are rare, and usually rest in bed is the only treatment unless light traction is applied to relieve pressure on head. No weight-bearing for six months.

2. Head fracturing through acetabulum is treated by traction in line of neck. Leg is held in marked abduction by plaster spica unless rim of acetabulum is fractured, in which case traction should be used (longitudinal and lateral).

3. Fractures in upper end of femur with separation of trochanters. Heavy traction with thigh flexed, so that displaced lesser trochanter will be approximated.

4. Fractures of base of neck. Heavy traction.

5. Fractures of narrow part of neck. Healing uncertain because of small cross section of bone and poor circulation. Traction or abduction plaster.

General anaesthetics are not used by the author because it is desired to conserve the strength of the patient and not cause any more shock than necessary. The careful handling of the patient and close attention to details is highly commended by the authors. —*P. M. Girard, M.D., Dallas, Texas.*

ACUTE FRACTURES OF THE PELVIS. Treatment and Results in One Hundred and Twenty-five Cases. Lloyd Noland and H. Earle Conwell. *J. Am. Med. Assn.*, XCIV, 174, Jan. 18, 1930.

The authors reported a series of 125 cases of acute fractures of the pelvis over a period of eight years. Standardization of methods of treatment was recommended by use of overhead pelvic suspension hammock, with traction to lower extremities.

Complications noted were blood in urine, lacerations of urethral mucosa, extraperitoneal rupture of bladder, rupture of deep urethra, intraperitoneal rupture of bladder, laceration of perineum, rupture of kidney, fracture of femur, and dislocation of the hip. As associated injuries, pneumonia, generalized peritonitis, and general septicaemia were the primary causes of mortality.

In case of peroneal nerve trauma occurring in lumbosacral cord at the pelvic rim, massage, electrotherapy, foot-drop support and use of stop joint at the ankle were advised.

Oedema, a result of severe injury to deep blood supply, was noted in several cases, with disability varying from slight degree to permanence.

Treatment recommended is roentgenograms, physical examination, appropriate measures for shock, and securing specimen of urine for determination of ruptures. In case of the latter, appropriate surgical measures are resorted to. Overhead pelvic suspension hammock, causing disposition of displaced fragments into a natural position, is supplemented by traction on legs and thighs with fifteen degrees to twenty degrees of abduction of thighs at hips. The amount of weight on hammock suspension is regulated by weight of body area which hammock supports. The weights for leg traction vary from four to eight pounds, depending on weight of patient and type of fracture. Leg traction is not used in isolated fractures of anterior-superior or anterior-inferior spines of crest of ilium. A pelvic belt, gradual weight-bearing, local heat, and close observation are the measures during convalescence.—*W. B. Carrell, M.D., Dallas, Texas.*

THORACIC AND LUMBAR SYMPATHETIC GANGLIONECTOMY IN PERIPHERAL VASCULAR DISEASES. Therapeutic Value. Alfred W. Adson and Geo. E. Brown. *J. Am. Med. Assn.*, XCIV, 250, Jan. 25, 1930.

Primary diseases of arteries of extremities are classified in two main groups:

1. Those of vasomotor or functional disorders, ranging from mild to severe dilatation constriction,—the later includes Raynaud's disease. Obviously, this disease would be improved by surgical measures to produce dilatation of vessels; also, the converse is true.

2. Organic diseases: Thrombo-angiitis obliterans and arteriosclerosis with thrombosis. The cause of scanty blood supply in these extremities has been found to be twofold,—namely, limitation due to occlusion of the artery, and vasospasms of the collateral vessels. Some cases have the associated collateral vessel spasm and others do not. Cases with the vasospasm of collateral vessels are improved by ganglionectomy and those without it are not.

In order, therefore, to determine which case is suitable, the authors have devised a clever skin temperature index determined as follows: The oral temperature and skin temperature of extremity are taken; high fever is then produced by use of typhoid vaccine. This relieves vasospasm of collateral vessels if present. The cases in which the surface temperature would increase two or more times the increase in the oral temperature were considered suitable for operation. Of course, other factors are also to be considered, such as age, occupation, etc. About one of every six or seven cases observed in the last two years fulfilled the requirements of the authors for operation.

A number of cases are reported in which excellent and permanent results were obtained; also, some few cases reported in which results were not so good.—*W. B. Carrell, M.D., Dallas, Texas.*

VOLKMANN'S ISCHAEMIC CONTRACTURE. Henry W. Meyerding. *J. Am. Med. Assn.*, XCIV, 394, Feb. 8, 1930.

The author reports the results of a series of 128 cases. Emphasis is made that this type of contracture is not necessarily due to neglect, tight bandages, casts, etc., but may be due to primary injury to vessels, especially blocking of venous return. The changes are due to degeneration and fibrosis. Intrinsic pressure, such as hemorrhage, may be the causative factor. Patients always gave a history of pain, swelling, numbness, and change of color in the extremity.

Early operation in cases which are liable to ischaemic contracture is advocated, washing out the clot, approximating the bone ends if necessary with a beef-bone screw, and early motion, thus reestablishing circulation.

These cases resulting from trauma to the extremity were usually associated with fracture. The treatment should be early prevention or correction of intrinsic or extrinsic constriction.

When once a diagnosis of ischaemic contracture is made, treatment of the fracture should be abandoned and attention given to the circulation. If other measures fail, deep incision should be made and warm moist dressings applied. When the duration is of days or of weeks, use only heat and splints to keep the flexors stretched. Forceful stretching under anaesthetic is not beneficial.

In the cases of longer standing, surgery offers aid in correcting deformities only if satisfactory muscle function remains.—*W. B. Carrell, M.D., Dallas, Texas.*

FUSION OF THE KNEE IN THE PRESENCE OF INFECTION. C. F. Eikenbary. *J. Am. Med. Assn.*, XCIV, 391, Feb. 8, 1930.

Cases suitable for fusion are, notably, tuberculous and compound infected fractures involving the knee joint. These patients must either be content to be semi-invalids with slightly painful motion, or have a fusion done. Cases which might prove suitable for arthroplasty are excluded.

Case reports given show satisfactory results. Infrequent dressings are recommended.—*P. M. Girard, M.D., Dallas, Texas.*

POLIOMYELITIS. Robert H. Riley. *J. Am. Med. Assn.*, XCIV, 550, Feb. 22, 1930.

Statistics of the incidence of the disease in Maryland since 1916 are given. The fact that there were but four per cent. of families out of 8,635 families in 1916 which had more than one case is carefully noted.

Date is given on the number occurring in each family and also the age incidence. Of 1521 cases, sixty-eight per cent. were under five years of age. The seasonal incidence shows more cases during the winter months.

The mortality rate is carefully outlined. From 1894 to 1921, twenty deaths per hundred thousand population occurred. In 1916 Maryland had eight deaths per hundred thousand population. Other figures also show that more modern methods have definitely cut down incidence and mortality rate.

Treatment: Intravenous and intraspinal convalescent serum given at the same time, followed on successive days by additional intraspinal injection, gave best results if given early. Orthopaedic measures and occupational therapy are discussed.

The paper gives excellent statistics in all phases discussed.—*W. B. Carrell, M.D., Dallas, Texas.*

KYSTE DU MÉNISQUE EXTERNE CHEZ UN ENFANT (Cyst of the External Meniscus in a Child). Nové-Josserand and Pouzet. *Lyon Chir.*, XXVI, 725, Sept.-Oct. 1929.

The authors present a case of cyst of the external meniscus in a child eight years old. The cyst was removed by an arc-shaped incision with posterior convexity. The excision of the cyst necessitated resection on to the tuberosities of the tibia, and the entire joint space between tibia and fibula. The lateral ligament had to be sectioned

in order to reach the posterior horn of the cartilage; the anterior was severed at its point of insertion. The patient made an uneventful recovery.

Some time ago Mouchet and Tavernier reported on the pathology of the menisci of the knee. Cysts were rare, and up to that time only thirty of these cases had been reported in the literature. It is interesting to note that these cysts usually occur in young individuals between twenty and twenty-five years of age but no case has heretofore been described in a patient as young as eight years. In the author's case there was no traumatic incident revealed in the history and the cyst developed absolutely insidiously without any of the usual symptoms of internal derangement, such as pain, limping, or lockage. In this particular case the cyst was rather extensive, extending through the entire thickness of the posterior horn of the cartilage. The classical cyst develops more in front, at the union between the anterior and the middle third of the meniscus. The anatomical reconstruction of the capsule is less rapid and complete in those cases in which large cysts had to be removed with considerable technical difficulty. In this case it was necessary to fix the capsular tissue to periosteal and fibrous layers as they presented themselves in the operative field. Because of these difficulties the period of immobilization was somewhat extended, being twenty days, after which time the general routine of physiotherapeutic mobilization was instituted.—*A. Steindler, M.D., Iowa City, Iowa.*

TUBERCULOSE JUXTA-ARTICULAIRE DU COUDE CHEZ L'ENFANT (Juxta-articular Tuberculosis of the Elbow in the Infant). Nové-Josserand and Pouzet. *Lyon Chir.*, XXVI, 737, Sept.-Oct., 1929.

The authors report seventeen cases of tuberculosis of the elbow, among which the majority were juxta-articular lesions. In the region of the elbow these lesions have a particular clinical aspect, due to the constitution of the articulation. Among these seventeen observations, six were humeral and eleven cubital tuberculosis (tuberculosis of the ulna). The ages range from nine years to seventeen years for the humerus and from three years to fourteen years for the ulna.

The seat of the tuberculous focus in the humerus varies. Among the six cases, four lesions were frankly metaphyseal and two occupied exclusively the external condyle. In the ulnar type one deals always with the diaphyseal lesions in the neighborhood of the sigmoid fossa.

Radiographically the epiphyseal lesions of the humerus appear most often in form of circumscribed foci, sometimes surrounded by a condensation of bone. Occasionally they show a sequestrum. There is usually only slight reaction of the periosteum. At intervention one finds a cavity containing fungosities and caseous material, and at other times simply rarefied osseous tissues with tuberculous granulations. In the ulnar type x-ray pictures always show cavities in the neighborhood of the sigmoid fossa. In six cases these cavities were limited, in three others they had more of a diffused character, and one was found with a large sequestration. Only in one case was there isolated periostitis, though in general periostitic reaction is the rule.

At operative intervention one encounters, after removal of the periphery, fungus masses and softened bone tissues. In four cases caseous material was found, and small sequestra were encountered in four others.

The lesions of the humerus in older children are either metaphyseal or epiphyseal, that is, within the condyles; whereas in the ulna they are found in almost any age at their usual seat in the neighborhood of the coranoid fossa. The lesion is only rarely found in the radius.

Foci of the humerus as well as those of the ulna give rise to arthritic signs, but in smaller children they may remain latent and be confined to a synovial involvement. It is, therefore, well to consider the articulation as being always involved in the process. In all the cases of the metaphyseal elbow involvement, that is, in fourteen out of sixteen, surgical removal of the tuberculous focus proved very efficient and assured definite healing with good function of the articulation. It is essential that the removal of the

focus be complete and that a period of immobilization follow the operation so as to allow for healing of the synovial lesion which may take five to six months. Nevertheless, in cases in which the joint involvement is severe, it is better to postpone the surgical intervention until after a certain period of immobilization in order to allow recession of the arthritic symptoms.—*A. Steindler, M.D., Iowa City, Iowa.*

THE INNERVATION OF STRIATED MUSCLE. Herbert J. Wilkinson. *Med. J. Australia*, II, 768, Nov. 30, 1929.

This article is the report of an elaborate research, the object of which was to prove or disprove the thesis of Boeke and later of Hunter and Royle, that striated muscle is innervated by both somatic and sympathetic nerves. The sympathetic innervation was thought to be the mechanism by which the tone of muscles is maintained. The technique of the study is fully given, and the evidence presented in forty-six beautiful reproductions of photomicrographs and drawings and several diagrams.

The conclusions reached are that it is very doubtful whether any histological evidence of a direct innervation of striated muscle fibers by sympathetic nerves exists. When undoubted sympathetic nerve distribution was traced into striated muscle, it was found to innervate, always and only, the smooth musculature of the vascular system; and the author believes that the effects of cutting sympathetic nerves,—*viz.*, slight increase in volume and temperature, with sometimes loss of tone and increased fatigueability,—are all due to changes produced in control of circulation.—*Edward N. Reed, M.D., Santa Monica, Calif.*

ANKLE FRACTURES. A New Classification and a New Class. F. J. Cotton and Richard Berg. *New England J. Med.*, CCI, 753, 1929

These cases are considered, by the authors, as dislocations complicated by fractures. Four types are given:

1. Pott's, outward dislocation.
2. Reversed Pott's, inward dislocation.
3. Cotton's, backward dislocation.
4. Upward dislocation—the type that has been sadly neglected.

The treatment is briefly outlined as follows: Reduction and plaster boots for six weeks for both Pott's fractures; seven to ten weeks for the backward displacement types, followed by braces with supporting straps for the valgus or varus deforming tendencies, with built-up heels. In all cases the joint of the brace should be fixed at right angles. The authors still maintain that the outward type should be reduced and put up in the varus position. The posterior type should be locked in dorsiflexion. Exercises to strengthen the tibial and flexor muscles should be given.

The fourth type is caused by a fall on the sole causing a compression of the lower end of the tibia, and seldom accompanied by a fracture of the os calcis or astragalus. Clinically the internal malleolus is higher than the external, and the x-ray confirms the diagnosis. It takes about six months to get a good result. The treatment is to pull the foot down, reshape the tibia, and get traction either by a skate, boot, or tongs in the os calcis. It may be necessary to remove some fibula to prevent impingement. The convalescent treatment is the same as for the other types.—*J. Kulowski, M.D., Iowa City, Iowa.*

OSTEOCHONDRITIS OF THE HIP AND OF THE ISCHIOPUBIC BONE. M. Ciancio. *Ortopediae Traumatologia dell 'Apparato motore*, Vol. 1, No. 3, 1929.

The author reports one case, a child of three years who was presented in the out-patient clinic with limp on the right side and with pain in the region of the hip joint as well as of the knee. The x-ray pictures revealed, aside from definite signs of osteochondritis of the hip, an isolated focus of osteochondritis of the ischiopubic junction of the same character as that in the head of the femur.

The author goes at length into the theories of the etiology of osteochondritis, and

believes that there are many indications which favor the assumption of an inflammatory origin of this condition, possibly coming from lesion of the upper respiratory tract and representing mild pyogenic infections. The clinical symptoms rapidly subside, and in those cases in which the pain persists changes of arthritis deformans are usually noticeable. The disease may heal with lengthening of the limb. In typical and uncomplicated cases there is a restitution *ad integrum* of the articular head.

Many undefined disturbances of young individuals may find their cause in foci of osteochondritis which have remained unnoted for a long time owing to the late appearance of radiographic signs.—*A. Steindler, M.D., Iowa City, Iowa.*

THE RÔLE OF HETEROGENOUS GRAFTS IN PLASTIC SURGERY OF THE BONE. N. Markelow. *Othopedia i Travmatologia*, I–II, 58, 1929.

Clinical and roentgenographic observations of heterogenous bone grafts bring the author to the following conclusions:

1. The general opinion that those grafts do not as a rule unite, needs revision.
2. In plastic operations where fusion of bone is required, the heterogenous grafts can be successfully used.
3. In fusion of the spine, those grafts can be prepared before the operation; the operative time is thus shortened and the trauma is lessened.
4. The heterogenous graft has unquestionably justified its use as a bone peg.
5. The rate of absorption of the graft, as shown by repeated x-ray examinations, depends on the surrounding tissues; it is faster when in direct contact with bone and slower in the presence of soft tissue.
6. The absorption of a graft produces stimulation, which increases the deposition of calcium salts.—*Emanuel Kaplan, M.D., New York, N. Y.*

DEFECTIVE DEVELOPMENT OF THE SPINE IN THE ETIOLOGY OF ITS DEFORMITIES. Prof. G. Turner. *Orthopedia i Travmatologia*, I–II, 9, 1929.

The author calls attention to the widening of interest and understanding of the functional affections of the spine, due to anatomical researches as well as deeper penetration into the complicated process of its phylogenesis and ontogenesis. The orthograde position of man brought notable changes into the mechanical adaptation of the spine. When investigating its anomalies, it is necessary to study the whole spine with the elements of the chest in their embryonal development. The problem is an extremely difficult one. A detailed review of anomalies with analyses is presented. Due credit is given to American authors. The writer describes two of his preparations: one illustrating a very early intra-uterine defective segmentation of the spine; the second, an abnormal regional differentiation of the vertebrae with incomplete sacralization of the fifth lumbar and dorsalization of the seventh cervical with a supernumerary pair of ribs. Both preparations are of adult spines. The author comes to the conclusion that the etiology of scoliosis requires a revision, and wishes to bring the orthopaedic surgeon nearer to the primary ground upon which the deformities of the cervical and dorsolumbar spine develop.—*Emanuel Kaplan, M.D., New York, N. Y.*

OPERATIVE RECONSTRUCTION OF THE PARALYTIC FOOT FOR PASSIVE WEIGHT-BEARING FUNCTION. Recurvatio Femoris in Paralysis of the Knee Muscles. S. Novotelnow. *Orthopedia i Travmatologia*, I–II, 44, 1929.

The following conclusions are brought forth by the author:

1. Rigid principles of statics in relation to bone levers and rules concerning the construction of braces movable in three joints, have to enter into consideration when reconstruction of a paralytic foot is considered.
2. A paralyzed lower extremity with motion in the three main joints may give a good passive support for the short period of weight-bearing on walking, when the center of gravity line passes behind the hip joint, in front of the knee and ankle joints, coming down behind the toes.

3. Mild paralytic flexion contractures of the hip and knee, genu valgum and equinus of the foot, must not be interfered with, as they are very useful for stability and may be saved for static reconstruction.

4. To secure a passive movable support in a paralytic hip joint, the iliofemoral ligament must have sufficient tension to counter-balance the motion of the pelvis backward. In the presence of marked flexion deformity of the hip joint, this is obtained by subtrochanteric osteotomy with extension of the thigh.

5. The foot is best immobilized by arthrodesis or by Putti's operation with moderate equinus. The fixation of the foot in equinus serves not only for passive support of the ankle joint but also to stabilize the moderate flexion deformity of the paralytic knee.

6. Recurvatio genu is sometimes a natural adaptation useful in reconstruction of the deformed leg. It shows the principle of how to rebuild the knee for passive support.

7. To secure a movable and passive support of the paralytic knee, the method of recurvation of the thigh by supracondylar osteotomy is of great value. The stability of the knee is then due to the surrounding ligaments. The recurvatio femoris, surgically formed, is of special value when the flexors of the knee are partially saved and a flexion contracture is present with genu valgum, which adds to the stability of the knee by stretching out the fascia lata.

8. Arthrodesis of the knee is a less desirable procedure for the patient than recurvation, because an elastic movable limb is more useful when the patient is walking and more convenient when he is sitting, than an inflexible extremity created by arthrodesis.

9. Recurvation is out of place in the presence of a posterior subluxation and flail joint, particularly when there is additional instability of the hip joint. These cases require arthrodesis or mechanical support.

10. Recurvation of the femur may be secured by osteotomy or metaplasia proposed by Vreden. This operation is better when very marked flexion contracture of the knee is present.—*Emanual Kaplan, M.D., New York, N. Y.*

CHANGES IN PRIMARY AND METASTATIC BONE TUMORS FOLLOWING VARIOUS DOSES OF ROENTGEN RAY. Ralph E. Herendeen. *Radiology*, XIII, 326, Oct. 1929.

The response of primary bone tumors to irradiation by roentgen or radium rays is dependent on several factors. Most important are the age of the patient and the character of the tumor, the latter including the degree of malignancy, rate of growth, size, location, origin, and tendency to destroy or produce bone. Response is delayed in the presence of chronic constitutional disease, fractures, infection, and following biopsy; and under these circumstances caution must be used in increasing dosage lest normal tissues be damaged and bone regeneration delayed.

Biopsy gives little information which cannot be otherwise obtained, in bone tumors, and entails the hazard of dissemination of tumor cells, infection, and of delaying and reducing the effects of irradiation.

In their order of sensitivity to irradiation, bone tumors are:

1. Endothelial myeloma (Ewing's tumor).
2. Giant-cell tumor.
3. Multiple myeloma.
4. Osteogenic sarcoma of destructive type.
5. Osteogenic sarcoma of mixed type (destructive and productive).
6. Osteogenic sarcoma of sclerosing bone-producing type.

The effect of irradiation on secondary bone tumors is less certain. Probably the largest number of metastases in bone calling for irradiation come from mammary cancer. Fortunately these respond better to irradiation than do those from any other gland, while those from hypernephromas, and from tumors of the bladder and the prostate are least responsive; those from the cervix, mouth, tongue and lips are also disappointing in their response to radium or x-ray.

Ewing's tumor occurs usually in children, and shows rapid growth and elevation of temperature,—hence is usually diagnosed osteomyelitis. The films show slight decrease in density, slight widening of medullary cavity, with a little change in the periosteum and thinning of the cortex, the process involving a large portion of the shaft. The response to irradiation, which should be in heavy dosage, is prompt and striking.

In giant-cell tumors a large dose is followed by prompt response, with swelling, redness and tenderness which may cause useless alarm and recourse to surgery. Large doses and severe reaction are unnecessary and unwise. Most giant-cell tumors which have become malignant have been located in the head of the tibia, and have been treated by Bloodgood's method,—*i.e.*, curettage. Some had metastases to the lungs like osteogenic sarcoma

The author feels that the evidence all shows the advantage of radiation over curettage in giant-cell tumor: also that the chance for success of curettage is considerably less in the upper end of the tibia than in the lower end of the femur. The operation of curettage may be responsible for the transition from benign to malignant of a giant-cel' tumor, having destroyed the mechanical barrier placed by the tissues around the tumor. Irradiation also has failures, due probably to overheavy dosage, which may also destroy the mechanical barrier.

In osteogenic sarcoma, irradiation may be followed by a period of comparative quiescence and encapsulation; amputation during this period gives the best chance of cure.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Osteitis Fibrosa, Monocystic, Polycystic, and Diffuse. Edward T. Evans. *Radiology*, XIII, 530, Dec. 1929.

Evans classifies three types of disorder in calcium metabolism,—*viz:*

1. Failure to absorb calcium from the alimentary canal, as in rickets.

2. Failure by tissues to utilize calcium absorbed. The ionic or active calcium is decreased, the colloidal calcium normal or above normal in amount.

3. An error in the regulation of calcium excretion, as seen in tetany and spasmophilia.

The majority of cases of osteitis fibrosa show normal or low normal blood calcium, ruling out the first type. The second type probably does not qualify as the cause, since some bones or parts of bones utilize the calcium normally. In osteitis fibrosa polycystic there must, then, be a local change in the bone leading to local non-utilization of calcium. The local reactions are those of a low-grade infection. In regard to the single cyst and to diffuse unencysted osteitis fibrosa, the author feels that the weight of evidence and of opinion is that the process is primarily infectious.

His classification is:

1. Osteitis fibrosa polycystic, of probably constitutional basis plus possible infection.

2. Osteitis fibrosa monocystic, of infectious origin, often associated with trauma.

3. Osteitis fibrosa diffuse, of infectious origin, often associated with trauma but dependent on local metabolic factors as yet undetermined.

It is a disease attacking principally long bones, producing cysts, progressing for some time, then stationary, not shortening life but often resulting in fractures and deformity. In early life it must be differentiated from fragilitas ossium and from dyschondroplasia; later in life from Paget's disease and from osteomalacia.

Local trauma is a primary etiologic factor, with a constitutional basis behind it, and possibly, infection. The prognosis as to cure is hopeless. There is no standardized general treatment. Locally, operative treatment, breaking in the cyst walls and producing a mass of freshly broken osteoid tissue which regenerates callus, is very satisfactory. Three cases are reported in detail.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Anomalies Rotuliennes (Patella Bipartita) et Fracture Méconnue de la Rotule. (Patellar Bipartite). E. Roussel and A. Mouchet. *Rev. d'Orthop.*, XVI, 511, Nov. 1929.

The authors present a report of two cases with radiographs.

There was absence of traumatism in one case, direct traumatism followed by hemarthrosis in the other. In the first case there was a chronic arthritis of both knees, appearing in the wake of an articular rheumatism. The right knee showed an abnormal patella, which seemed to play no part in the hydrarthrosis of the joint.

The anomalies of the patella have been known since the existence of a bipartite was pointed out first by Gruber in 1883. Reinhold, of Lausanne, called attention to the diagnostic difficulty which these congenital anomalies present in evaluating trauma of the knee joint. And Mouchet particularly insisted upon the part which these anomalies play in the production of painful patella, with or without hydrarthrosis, in infancy and adolescence. He applied the term of patellitis of infancy.

The other observation of the authors was an anomaly of the patella causing pain and hydrarthrosis in a child of eight years. The radiogram showed a typical bipartite patella of the left side, whereas the right one was absolutely normal.

The authors point out the diagnostic difficulty in the former publications on patellar bipartite, where the observers emphasize as essential for the diagnosis of the congenital anomaly the bilaterality of the lesion in contrast to the unilaterality in partial fractures.

The observations of the authors show that the patellar anomaly may be unilateral as well as bilateral.—*A. Steindler, M.D., Iowa City, Iowa.*

The Study and Treatment of Scoliosis. A. B. Ferguson. *Southern Med. J.*, XXIII, 116, Feb. 1930.

Roentgenograms, made both lying and erect, are the only satisfactory means of studying this condition and determining the value of treatment. Braces and jackets do not stop the progress of the deformity. Gymnastics are ineffectual in treating this deformity, but they do improve the general condition.

The only treatment that is effective in stopping the progress of a curve is operative fusion. The deformity is first corrected as much as possible by turn-buckle jackets.

Indications for operations are (1) unsightly and correctable deformity, (2) physiologically deleterious and correctable curve, (3) progressing deformity, (4) severe pain.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

Bone Graft in Ununited Fractures. J. S. Speed. *Southern Med. J.*, XXIII, 179, Mar. 1930.

Theoretical considerations of viability of grafts, value of periosteum, fate of graft, and causes of non-union are discussed. The author uses a massive autogenous onlay graft, fixed in place with bone pegs. The details of the principles of this operation are described. Results in 120 bone grafts for non-union in the shaft of long bones are given. Period of non-union varied from four to twenty years. Two cases operated upon two and a half years after an infected compound fracture developed a severe reinfection. Rigid asepsis is essential to success. In 109 clean cases, nineteen, or seventeen per cent., developed some infection, but none were severe; eight of these obtained union, in eleven a part or all of the graft was lost, but seven of these went on to solid union. Of 120 cases in all groups, there were nine failures, or seven and five-tenths per cent. Solid union was obtained in 111 or ninety-two and five-tenths per cent.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

Spätruptur der Sehne des Extensor Pollicis Longus (Delayed Rupture of the Tendon of the Extensor Pollicis Longus). Fritz Lülsdorf. *Ztsch. f. orthop. Chir.*, LI, 191, 1929.

Subcutaneous ruptures of tendons are generally placed in three categories: (1) those occasioned by direct violence; (2) those occasioned by indirect violence, as sudden contraction; (3) the so called spontaneous ruptures.

It is the third group which is considered by the author. He remarks that although degenerative processes in tendons occur in typhoid, scarlet fever, cholera, syphilis, and tuberculosis, rupture is not observed. Furthermore, it is doubted by some that normal tendons can rupture spontaneously. Ledderhose and Heneke remarked that the rupture of the long tendon of the biceps followed a previous arthritis of the shoulder joint. Müller has, on the other hand, described changes in the tendon in such ruptures which signify that the blood supply to the tendon had previously been cut off.

The classic tendon rupture is the "drummer's palsy". Zander described it first as a traumatic paralysis of the extensor pollicis longus. It was Duplay who recognized that the tendon was ruptured and first operated on the condition. Since 1881 many cases have been reported.

The pathology appears to be a chronic tendinitis arising as a result of the tendon working in an unfavorable position. In extending the finger it is angulated over the tense sharp edge of the carpal ligament at an angle of 120 to 160 degrees radial abduction. Repeated trauma evokes inflammation, and it is this diseased tendon which eventually gives way at a point distal to the carpal ligament. The alteration in the tendon is, as a rule, limited to the region of rupture.

The author's report concerns a fourteen-year-old female who fell on her outstretched hand and sustained a fracture of the radius at the wrist. There was no displacement. Soon after, a circumscribed swelling, the size of a hazel nut, was observed over the tendon of the extensor pollicis longus. The wrist was immobilized and the swelling, apparently a hematoma, was absorbed. Movement of the thumb was normal. However, twenty-eight days after the injury, without a further trauma, the tendon parted and the typical signs became apparent. At operation, the distal end was found at the superior border of the carpal ligament. The proximal end had retracted and was adherent at the level of the inferior border. The tendon was soft, yellow white, and flayed. The tendon sheath grossly appeared normal. A "Z" lengthening was performed, and ten weeks after operation, normal function was present.

In this case the primary trauma is indicated as responsible for the production of a change in the tendon which subsequently led to its rupture. Compression at one point or injury to its blood supply are invoked as possible explanations. The possibility of the occurrence after wrist fractures should be remembered when considering the best position for immobilization.

As far as therapy is concerned, operative plasties are the methods of choice, conservative return having been obtained only in one case reported by Lindner. Vierling has demonstrated that both the tendon ends may grow to the sheath and that function may, in such a fashion, be obtained.

A comprehensive bibliography is appended.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Ein Beitrag zur Ätiologie und Therapie des Klauenhohlfusses (A Contribution to the Etiology and Therapy of Claw-foot). A. Beykirch. *Ztschr. f. orthop. Chir.*, LII, 1 Heft, 41, 1929.

The essential claw-foot is associated in the literature with spina bifida occulta. However, statistics quoted by Beykirch indicate that the latter spinal abnormality is of surprisingly frequent occurrence in the first and second decades, and that claw-foot is found as often as not without spina bifida. Thus of sixty-nine cases of the author, thirty-four (49.3 per cent.) had a spina bifida occulta, while thirty-five (50.7 per cent.) had none.

None the less, the preponderance of evidence is in favor of the view that claw-foot is one of the chief symptoms of a developmental aberration involving the spinal cord (myelodysplasia). This developmental inferiority may express itself in spina bifida occulta, but the two are not necessarily causally related. Lipiodal exploration in three cases revealed no stenosis of the dural sac.

In analyzing a claw-foot deformity of moderate severity, attention is directed to the varus of the os calcis, the supination of the mid-foot and the pronation of the fore-foot. Two muscles are indicated as causal agents: the tibialis anticus and the peroneus longus. To the latter is attributed pronation of the fore-foot and plantar flexion of the first metatarsal. These agents are considered to operate as deforming forces because of a weakness of the tibialis posticus which was demonstrable clinically in the author's series. This weakness permits the supinatory power of the tibialis anticus to increase the varus of the back-foot. Secondarily, the dorsiflexors develop an abnormal line of pull.

The importance of the peroneus longus in the development of the condition was made known through Duchenne, Schulthess, Roeren, and Hackenbroch.

The plan of treatment includes: first, redressment in one or more sittings in the usual manner; second, a plan of operative treatment whose aim is to remove the deforming influence of the peroneus longus and to correct the varus position of the os calcis. The former is accomplished by division of the tendon and subsequent suture under tension of the central end into the outer side of the posterior end of the os calcis. The peripheral portion of the tendon is sewed without tension into the peroneus brevis. The varus of the heel is corrected by a wedge osteotomy of the os calcis such as Hohmann performs for club-foot, with the base of the wedge above and out, and its point below and in.

As a rule the severe cases have had a deformity of the great toe in association. Consequently the extensor hallucis longus has been transplanted into the first metatarsal bone as in the method of Scherb. Unfortunately there is a tendency for the great toe to gradually drop and the patients complain of the digit catching in their shoes when they attempt to draw them on.

Celluloid-steel anklets are used to immobilize the foot after operation.

Fifteen cases operated in this fashion resulted in painless, well-formed feet. The operation has proved most satisfactory in the hands of the author.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Über den kongenitalen Charakter juveniler Osteochondritiden des Hüftgelenkes (Concerning the Congenital Character of Juvenile Osteochondritis of the Hip-joint). Bozidar Špišič. *Ztschr. f. orthop. Chir.*, LII, 1 Heft, 60, 1929.

The author is convinced that Legg-Perthes-Calvé's disease results from traumas and weight-bearing exerting their injurious effect upon femoral heads located in congenitally malformed sockets. Of ten cases under his observation, seven possessed a spina bifida occulta of the lumbosacral region. Speaking for the congenital character of the disease, he tabulates these characteristics among others:

1. The deformity of the femoral head with intact periphery.
2. Short, broad, anteverted neck.
3. Shallow, vertical, upward displaced acetabulum.
4. Fragmentation of the epiphyseal head with abnormal ossification.
5. Frequent appearance of osteochondritis after reduction of a congenitally dislocated hip.
6. Similarity in history between the above two conditions.
7. Hereditary and familial characteristics of Legg's disease.
8. Frequent appearance, according to Brandes, of (Jansen) Legg's disease in the apparently healthy hip of a unilateral congenital dislocation.
9. Development of osteochondritis in one hip after the condition has healed in the other.
10. Negative histological and bacteriological findings.
11. Frequent association with osseous congenital defects in the lumbosacral region of the spine.

The author recapitulates the views of Calot, Jansen, and Brandes. He is apparently not aware of the relatively high incidence of spina bifida occulta in apparently normal individuals.—*J. E. Milgram, M.D., Iowa City, Iowa.*

ZUR PFANNENDACHPLASTIK. (A Plasty of the Acetabular Roof.) L. Roeren. *Ztschr. f. orthop. Chir.*, LII, 1 Heft, 86, 1929.

The article presents a variation on the shelving operation for unstable hips. Two broad pegs are removed from the tibial cortex and driven firmly into the ilium just above the roof of the acetabulum. They are each about three-fourths of an inch wide. The periosteal side is turned toward the femoral head.

Two cases were done satisfactorily. In one, reoperation was necessary in the tenth week after operation, because early weight-bearing had changed the pegs from a horizontal to an acute angle. In this case, bone was found forming between the medullary surface of the cortical peg and the ilium, while the periosteal surface appeared to be smooth.—*J. E. Milgram, M.D., Iowa City, Iowa.*

GENU IMPRESSUM UND PATELLA ALTA UND IHR VERHALTEN ZU BEKANNTEN ERSCHEINUNGEN, WIE FATTEINKLEMMUNGEN, KNORPELSCHÄDEN UND PATELLARLUXATION (Genu Impressum and Patella Alta and their Relation to Known Occurrences, as Impingement of the Fat Pad, Cartilaginous Injuries, and Dislocation of the Patella). Murk Jansen. *Ztschr. f. Orthop. Chir.*, LII, 314, 1929.

The author defines two conditions present in a large number of knees which predispose them to the complaints indicated in the title of the article. Genu impressum is characterized by a compression and backward displacement of the epiphyseal portions of the femur and tibia. It can be recognized in the lateral roentgenogram of the knee by these changes in the articulating portions of the tibia and femur. The fibula seems too high and too convex posteriorly. Patella alta vera is characterized by a patella entirely too high, its lower pole being no longer at the level of the articulation. He believes that in these conditions the fat pad is often caught between the patella and the femur as between the blades of a shears. Local cartilaginous erosions of the patella and the corresponding portion of the femur (often the diaphysis in his cases) occasion severe pain whose onset may be sudden. Inability to fully flex or extend the joint may be elicited.

Genu impressum is the result of "a relative or absolute insufficiency" of the bone substance which is unable to stand the stresses of locomotion in a normal fashion. The author distinguishes between combination of the two conditions and the individual syndrome. Most of the patients have been women. He compares the epiphyseal dysplasia to that of Madelung's deformity of the wrist. It is his opinion that one must rule out the genu impressum before one can diagnose as independent syndromes "fibrous hyperplasia of the fat pad" (Hoffa), "traumatic cartilage tears" (Budinger), "chondropathy" (Fründ or Läwen), "retropatellar contusion" (Patrik Haglund), "chondromalacia of the patella" (König).

As far as treatment is concerned, he utilizes rest in mild cases of genu impressum, and later the wearing of a brace or elastic bandage. In mild cases as well as old, or in obese patients, the removal of the fat pad is indicated. In severely altered patellae the patellar cartilage may be completely removed. In four cases he has transplanted the tuberosity of the tibia with the patellar ligament attached distally and maintained this position with the aid of a screw. In patella alta this procedure is always indicated. In some cases extension is associated with dislocation of one or both menisci. Removal of the semilunar cartilages may be necessary in these cases. If these are unavailing, osteotomy of the femur or tibia may be attempted.—*J. E. Milgram, M.D., Iowa City, Iowa.*